CAIS STANDARD MANUAL

SYSTEM NO. 32
CENTRAL
COOLING PLANTS

CAS PROJECT
CAIS MANUAL

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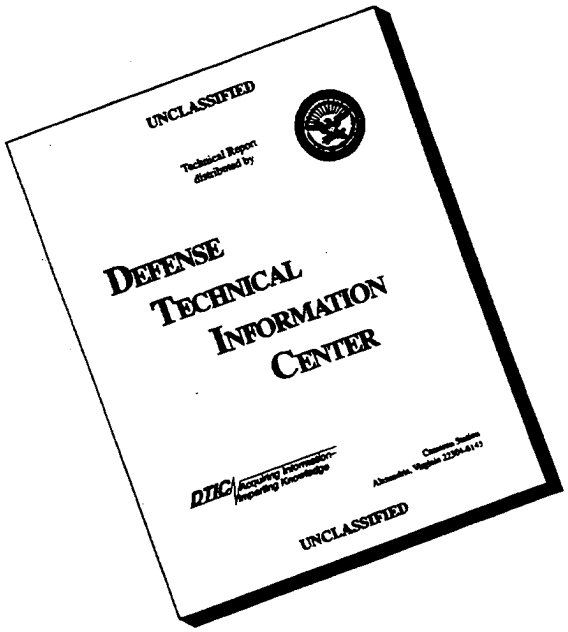

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SUBJECT: Transmision of Technical Documents

1. As per telephone conversation with Andrew Poulis, EQ/TIC, the attached CAIS CTDS manuals are forwarded for accession, cataloging, and microconversions. Please forward the accession numbers to:

Andrew Poulis
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139 Barnes Drive. Suite 2
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LARRY L. TESTERMAN
Scientific and Technical
Information Program Manager

Atchs: Manuals

32 CENTRAL COOLING PLANTS

TABLE OF CONTENTS

32 CENTRAL COOLING PLANTS

PAGE

SUBSYSTEM 32.02 CHILLERS - CENTRIFUGAL

SUBSYSTEM 32.03 CHILLERS - RECIPROCATING

SUBSYSTEM 32.04 CHILLERS - SCREW

32 CENTRAL COOLING PLANTS

PAGE

SUBSYSTEM 32.05 CHILLED WATER DISTRIBUTION SYSTEMS

SUBSYSTEM 32.06 CONDENSED WATER DISTRIBUTION SYSTEMS

SUBSYSTEM 32.07 COOLING TOWERS/EVAPORATIVE CONDENSERS

32 CENTRAL COOLING PLANTS

PAGE

SUBSYSTEM 32.08 AIR COOLED CONDENSERS - FLUID COOLER SYSTEMS

SUBSYSTEM 32.09 CHEMICAL WATER TREATMENT SYSTEMS

SUBSYSTEM 32.10 STEAM DISTRIBUTION SYSTEMS

32 CENTRAL COOLING PLANTS

PAGE

SUBSYSTEM 32.11 STEAM CONDENSATE RETURN SYSTEMS

APPENDICES

32 CENTRAL COOLING PLANTS

ABSTRACT

GENERAL ORGANIZATION

At this installation the list of facilities to be surveyed will be addressed on the basis of 32 unique systems that form the CAIS Engineering Deficiency Standards and Inspection Methods document. Each system deals with a specific technical aspect of the facility to be surveyed. Within each system a further breakdown is made to subsystems, each having a specific list of components. Specific observations of the listed defects are provided so as to allow the entry of observed quantification data. A DOD CAIS manual is provided for each of the 32 systems with an internal organization as outlined below:

INSPECTOR'S GUIDE

I. General
   - A. Level I Inspection Method Description
   - B. Level II Inspection Method Description
   - C. Level III Inspection Method Description

II. General Inspection
   - A. Process. This section describes the process of the inspection activity.
   - B. Location. This section describes the procedure for locating the inspection units in the facility or infrastructure on this installation.

III. Inspector Qualifications

This section notes the minimum qualifications for the person or persons performing the survey.

IV. Inspection Unit

This section describes how the IU (Inspection Unit) is determined for the particular component being surveyed.

V. Unit Costs

This section notes the nature of repair costs for this system.

VI. Standard Safety Requirements

This section lists safety procedures and equipment required to implement a safe environment for the conduct of this survey.

VII. Standard Tools

This section lists a set of standard tools required for the general conduct of this survey.

VIII. Special Tools and Equipment Requirements

This section refers to special tools or equipment requirements endemic to the nature of the system being surveyed.

32 CENTRAL COOLING PLANTS

IX. Level II Inspection Method Keys
This section explains the use of keys as they relate to Level II Guide Sheets.

X. Level III Inspection Method Keys
This section explains the use of keys as they relate to Level III Guide Sheets.

XI. Replacement Cost
This section describes the nature and location of replacement cost data.

XII. Appendices
Appendix A. Provides a listing and definition of all abbreviations used both in the Standards and in the data base.

Appendix B. Provides a glossary of terms with their definitions as used in the Standard.

Appendix C. This section contains a listing of the average life cycle durations for each assembly* in the Standard.

* Assembly is a term describing the level at which replacement rather than repair occurs. This can be at the subsystem or component designation, depending on the system being surveyed.

SYSTEM TREE

The System Tree is a graphical representation of the Work Breakdown Structure, showing system, subsystem and component relationships for the Central Cooling Plants.

INSPECTION METHODS

Description
Describes the nature of what is to be condition surveyed.

Special Tool and Equipment Requirements
Lists any special tools required for this specific subsystem.

Special Safety Requirements
This section outlines any special safety measures or equipment required for this specific subsystem so as to maintain a safe environment and process in the conduct of the condition survey.

Component List
All components to be surveyed under this subsystem are listed here.

Related Subsystems
All other subsystems that have a survey relationship to this subsystem are listed here to help coordinate a complete and thorough condition assessment survey.

32 CENTRAL COOLING PLANTS

Standard Inspection Procedure

This statement indicates the various levels of survey effort required for this subsystem.

Components

The previously listed components of this subsystem are described with a survey procedure recommended on a component by component basis. For each component there is a listing of defects with each defect broken down into observations describing the nature and severity of the defective condition observed. The surveyor enters a quantification value for each defect/observation encountered in the field CAIS device (DCD) to record the result of his survey.

References

This page lists the reference sources from which the foregoing subsystem data was developed.

Guide Sheet Control Number

This section lists the key numbers that tie the written Level II and Level III guide sheets to specific components in this subsystem.

Level II and Level III Inspection Method Guide Sheets

This section contains the detailed descriptions of the Level II and III survey and inspection procedures for this subsystem.

32 CENTRAL COOLING PLANTS

INSPECTOR'S GUIDE

I. GENERAL

A. Level I Inspection Method

The Level I Inspection Method for Central Cooling Plants consists of a thorough inspection of each subsystem and component as described in the Work Breakdown Structure. Portions of the system may be inaccessible during the Level I inspection. Only readily accessible components need to be addressed during a Level I inspection. The Level I inspection is designed to be performed by one inspector.

B. Level II Inspection Method

Level II inspections are triggered by defect/observations noted at the Level I inspection or in some cases, are required to conduct a meaningful survey of the component being inspected. The Central Cooling Plant requires very few Level II inspections, since most defects are readily apparent from a Level I. For instance, the investigation of grinding noises in a pump may dictate that a Level II inspection be performed. Level II inspections are referenced by defect/observations through a "Level II key", which denotes a specific Guide Sheet that describes the Level II inspection activity.

C. Level III Inspection Method

The Level III inspection is triggered by defect/observations occurring in the Level I and II inspections. The Level III inspection can also occur as a result of time based scheduling, antidotal experience, or component age compared to its life cycle. The Level III inspection is referenced through a Level III key which in turn, denotes a specific Guide Sheet describing the Level III inspection process and requirements. Level III inspections produce a detailed, written engineering assessment of the deficiency along with an estimated cost of correction, and are performed at the option of the Facility Manager.

II. GENERAL INSPECTION

A. Process

Surveys are normally conducted at the component level. Figure 32-A provides the breakdown from system through component for the Central Cooling Plants. The surveyor will work through the Work Breakdown Structure (WBS) to conduct the inspection. At the component level the surveyor will be provided a list of defects, each of which is described further in detail as observations. These observations are described to various levels of severity as they relate to the effect of the life of the system. The quantification of each deficiency is identified by the surveyor using the associated unit of measure. Once an observation is populated with a deficient quantity, the inspector will be requested to provide information on the component type and location. The installation date or age of the component may be preloaded into the WBS for each asset from the Real Property Inventory List or site specific information.

32 CENTRAL COOLING PLANTS

If necessary, age data can be overridden by the surveyor, Site CAIS personnel, or the Facility Manager.

B. Location

Level I and II inspections will be located by the surveyor through a discrete entry in the Field CAIS. Building floor plans or sketches are required to ensure a complete inspection of all areas and to assist in the location of IU's. The inspection team members must use the recommended room numbering schemes for the installation. The installation may have rooms physically identified by a numbering system or identified on floor plans. If both exist and are different, the Facility Manager will develop guidance on which numbering system takes precedence. Where numbering systems do not exist or are not complete in identifying each space, specific guidance for the inspector to annotate areas in a consistent manner should be developed by the Facility Manager and implemented in the installations CAS process. In all cases, plans and maps shall be orientated with the top of each sheet being the north direction, so as to allow directional location and description. In the case where no other means of location exist the inspector shall enter a brief (65 character) description of location. Locations must be accurate to insure future repeatability and consistent results.

III. INSPECTOR QUALIFICATIONS

The minimum inspector qualification for the Central Cooling Plants requires a five year journeyman. All of the condition survey requirements for this system can be accomplished at the Level I inspection by a single inspector, however, safety and other considerations may require that inspectors work in teams. The inspector or team of inspectors will be specifically trained in the CAS system and its usage and will be CAS certified in the "Mechanical" discipline.

IV. INSPECTION UNIT (IU)

The Inspection Unit (IU) is normally defined at the component level for this system. The varied configurations of the components that exist in the Central Cooling Plants require that they be evaluated differently when defining the IU. Therefore, the measurement technique requires some consideration. If the inspector finds multiple defects that occur on the same IU, the inspector will quantify the observation that is considered most severe and identify the remaining quantity under the less severe observation for the discrete component. The IU's for the most common components would be defined as follows:

- Piping, fittings and valves - The IU is defined as the linear footage of the affected section of pipe containing the defect in a particular location (to include the fittings and valves along that section). For example, five sections of 2" DIA pipe extend the length of a 20' wall within a mechanical room. If the inspector were to observe 2 LF of bent pipe on one 20 LF section, the IU would be 20 LF, not the total amount of 2" DIA pipe in the room of 100 LF.

32 CENTRAL COOLING PLANTS

- Valve, Sump, etc. - The IU for singularly defined items such as these are defined as each.

V. UNIT COSTS

The unit costs that are applied to the quantities recorded for each observation are contained within the Site CAIS as repair cost.

VI. STANDARD SAFETY REQUIREMENTS

The Master Safety Plan will be followed at all times during the condition survey.

Inspector may utilize the following protective gear:

- Hard hat - to be worn during all surveys
- Safety glasses - to be worn during all surveys
- Safety shoes - to be worn during all surveys
- Coveralls - to be worn as necessary
- Gloves - to be worn as necessary
- Ear plugs - to be worn in designated areas
- Knee pads - to be worn when crawling is required
- Rain suit - to be worn as necessary

VII. STANDARD TOOLS

Employee Identification Card - to be worn or carried during all survey activities
Data Collection Device (DCD)
Battery pack for DCD
Flashlight
Tape measure - 20' (or other supplemental measuring devices)
Screwdrivers - Phillips and straight slot
Pliers
Refrigerant gauges
Electronic leak detector

VIII. SPECIAL TOOLS AND EQUIPMENT REQUIREMENTS

At the subsystem level, the deficiency standard has identified special tools and equipment required for the standard inspection of the associated components, which exceed the standard tools identified for the system. Level III Inspection Method Guide Sheets will address additional tools and equipment requirements that are specific to that particular advanced method of inspection.

Facility Managers should review these sections in order to determine any special tool requirements for subsystems they are to inspect/survey.

32 CENTRAL COOLING PLANTS

IX. LEVEL II INSPECTION METHOD KEYS

Certain observations will reference a Level II Inspection Method. The Facility Manager will be able to identify deficiencies where a Level II inspection is flagged. The Level II key at the observation level will refer to a specific guide sheet.

All Level II Guide Sheets are located at the end of each Subsystem section. A Guide Sheet Reference page precedes Level II and Level III Guide Sheets.

X. LEVEL III INSPECTION METHOD KEYS

Certain observations will trigger a Level III inspection. The Facility Manager will be able to identify deficiencies where a Level III inspection is flagged. The Level III Key at the observation level will refer to a specific guide sheet. These guide sheets may refer the Facility Manager to a more sophisticated and costly test method.

All Level III Guide Sheets are located at the end of each Subsystem section. A Guide Sheet Reference page precedes Level II and Level III Guide Sheets.

XI. REPLACEMENT COST

A replacement cost for each subsystem type will be contained within the cost estimating system in the Site CAIS.

XII. APPENDICES

Appendix A - Abbreviations

A summary and definition of all abbreviations used in this system are contained in Appendix A which is located at the end of Central Cooling Plants.

Appendix B - Glossary

A glossary of terms used in this system are contained in Appendix B which is located at the end of Central Cooling Plants.

32 CENTRAL COOLING PLANTS

Appendix C - Life Cycles

A listing of the average life cycle duration for each assembly* in the Standard.

Note - Facility Manager's Guide

The following are included in the Facility Manager's Guide:

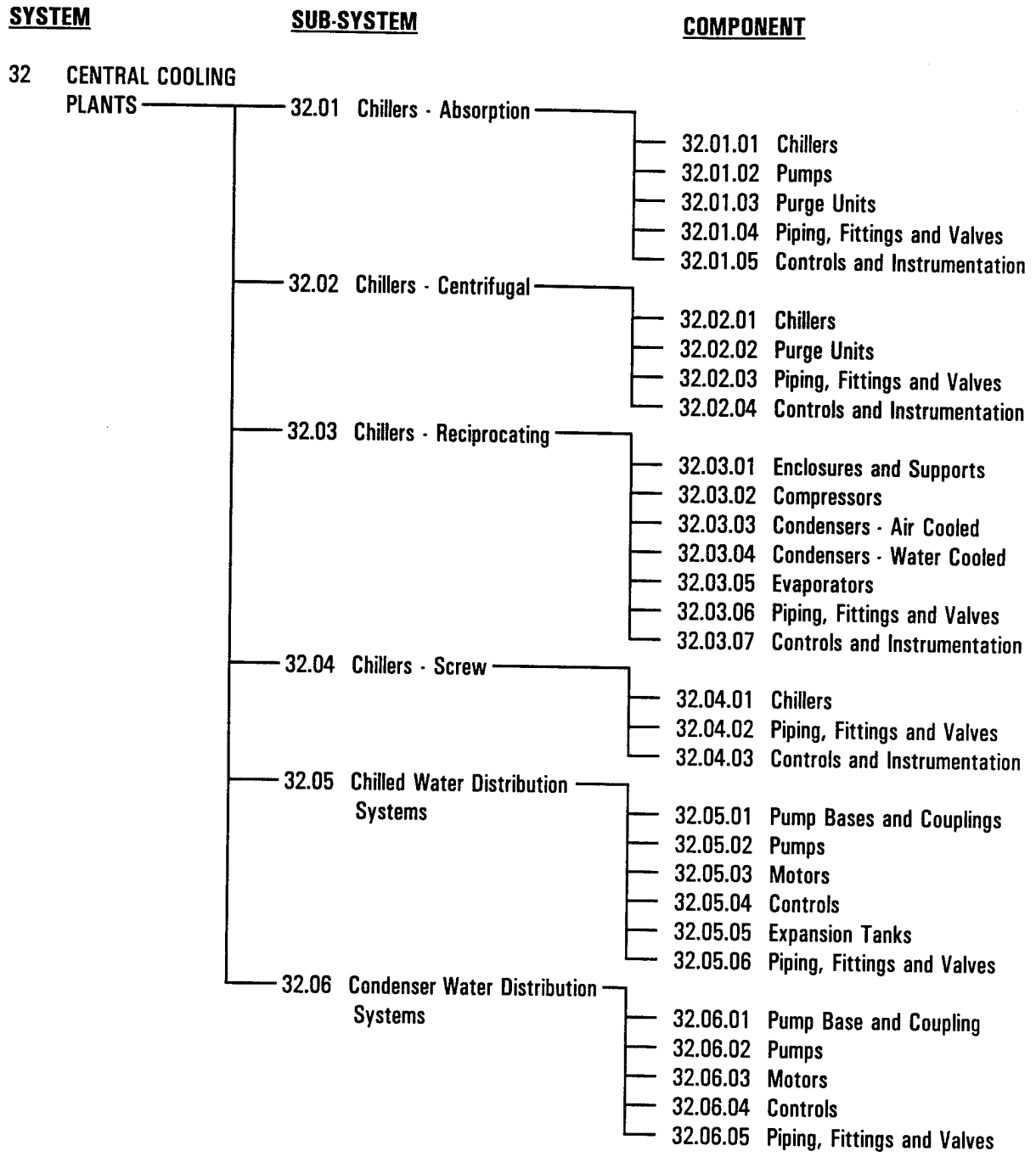
A table showing the required manhours to perform the standard inspection for this facility listed by Cat Code (three digit).

A listing of all Level III inspections with their estimated cost and time to perform. This list will include frequency of inspections for time driven Level III's.

* Assembly is a term describing the level at which replacement rather than repair occurs. This can be at the subsystem or component designation, depending on the system being surveyed.

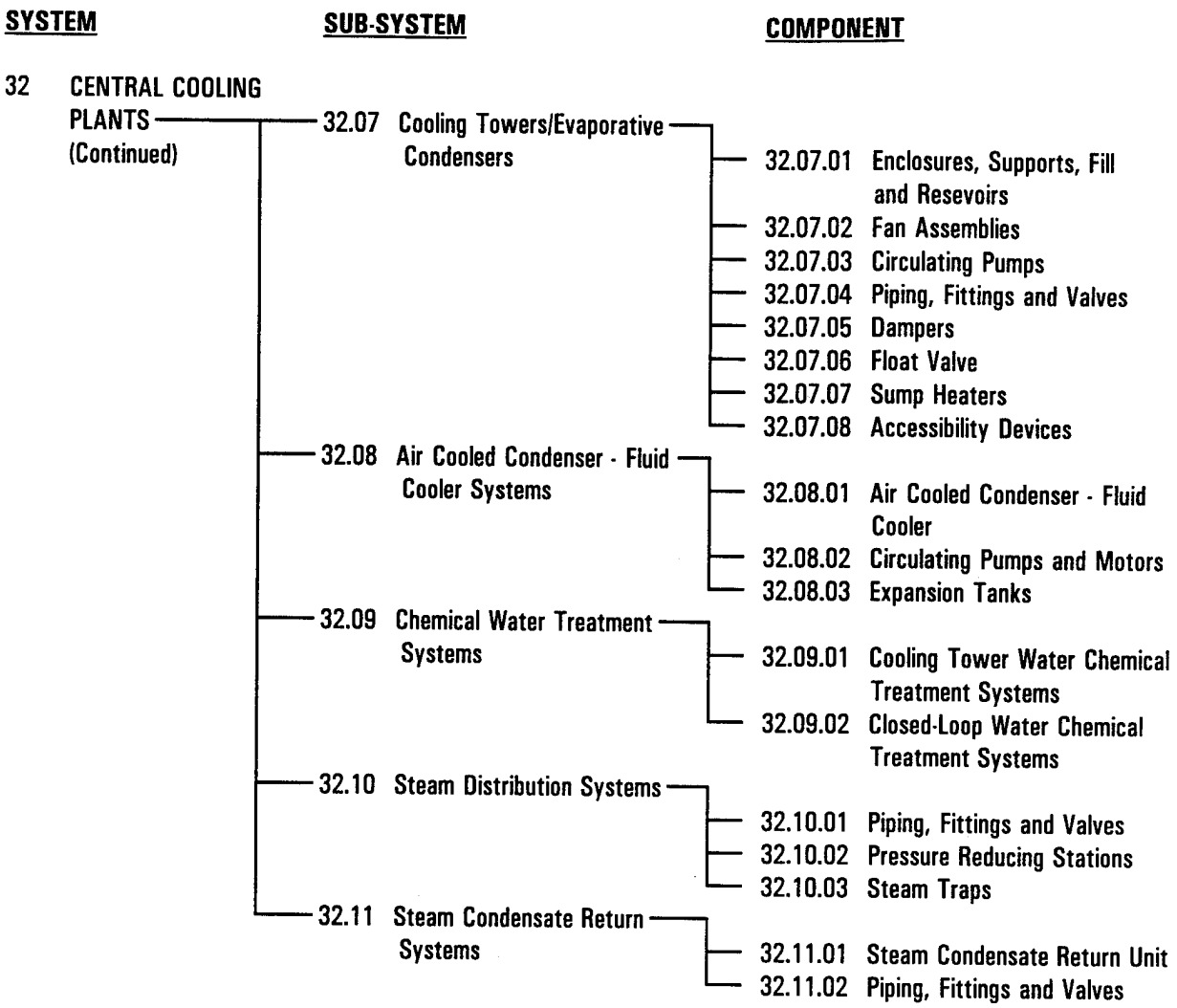
32 CENTRAL COOLING PLANTS

Figure 32-A. WORK BREAKDOWN STRUCTURE



32 CENTRAL COOLING PLANTS

Figure 32-A. WORK BREAKDOWN STRUCTURE (Continued)



32.01 CHILLERS - ABSORPTION

DESCRIPTION

Chillers - Absorption is a subsystem of the Central Cooling Plant. An absorption chiller uses water as the primary refrigerant and employs an absorbent as a secondary fluid. Unlike the centrifugal, reciprocating or screw units, it uses a physio-chemical process and employs little mechanical energy.

SPECIAL TOOL AND EQUIPMENT REQUIREMENTS

The following special tools and equipment are needed for the inspection of Chillers - Absorption System, beyond the requirements listed in the Standard Tools Section.

1. Electronic leak detector

SPECIAL SAFETY REQUIREMENTS

No special safety requirements are needed for the inspection of Chillers - Absorption System, beyond the requirements listed in the Master Safety Plan and System Safety Section.

COMPONENT LIST

- 32.01.01 CHILLERS
- 32.01.02 PUMPS
- 32.01.03 PURGE UNITS
- 32.01.04 PIPING, FITTINGS AND VALVES
- 32.01.05 CONTROLS AND INSTRUMENTATION

RELATED SUBSYSTEMS

Due to the related nature of the elements requiring inspection, the following subsystem should be reviewed for concurrent inspection activities.

32.05	CHILLED WATER DISTRIBUTION SYSTEMS
32.06	CONDENSER WATER DISTRIBUTION SYSTEMS
32.10	STEAM DISTRIBUTION SYSTEMS
32.11	STEAM CONDENSATE RETURN SYSTEMS

32.01 CHILLERS - ABSORPTION

STANDARD INSPECTION PROCEDURE

This subsystem requires both Level I and Level II inspection as part of the basic inspection process. Additional Level II inspections may be indicated or "triggered" by the Level I inspection observation and should be accomplished by the inspector at that time.

For electric motors in general use, Level I, II & III inspection methods will apply in accordance with the following horsepower ranges:

a. Use Level I inspection method if HP is less than 15.
b. Use Level I and/or II inspection methods if HP is 15 to 60.
c. Use Level I, II and/or III inspection methods if HP is greater than 60.

For fans, burner/blowers and blower assemblies, Level I & II inspection methods will apply. No Level III inspection will be required.

For pumps in general use, Level I, II & III inspection methods will apply in accordance with the following gallon-per-minute ranges:

a. Use Level I inspection method if GPM is less than 40.
b. Use Level I, II and/or III inspection methods if GPM is 40 or greater.

The Facility Manager will specify the level of inspection required for specialized motors, fans, pumps, blowers or blower assemblies.

Associated defects and observations, for each major component, are listed in the inspectors' Data Collection Devices.

COMPONENTS

◆ 32.01.01 CHILLERS

The chiller consists of a water cooled condenser, an absorber, an evaporator and a generator (concentrator). The latent heat of evaporation is provided by an external heat source or by direct fired gas or oil burners.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Excessive noise and vibration at the burner/blower.**			
Observation:			
a. Rattling noise.	EA	1	
*** {Severity M}			
b. Grinding noise indicating metal to metal contact.	EA	1	
*** {Severity H}			
c. Electrical arcing noise.	EA		
*** {Severity H}			

32.01 CHILLERS - ABSORPTION

COMPONENTS (Continued)

◆ **32.01.01 CHILLERS (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Leakage.**			
Observation:			
a. Evidence of water or absorbent leakage.	EA	2	
*** {Severity M}			
b. Evidence of fuel leakage.	EA		
*** {Severity H}			
*** Defective electrical connectors.**			
Observation:			
a. Loose conduit or connectors.	EA		
*** {Severity M}			
b. Exposed wires or missing cover plates.	EA		
*** {Severity H}			
*** Defective assembly hardware.**			
Observation:			
a. Loose assembly bolts.	EA		
*** {Severity M}			
b. Broken/missing assembly bolts.	EA		
*** {Severity H}			
*** Defective mounting hardware.**			
Observation:			
a. Loose base tie-down bolts.	EA		
*** {Severity M}			
b. Missing base tie-down bolts.	EA		
*** {Severity H}			
*** Defective insulation.**			
Observation:			
a. Loose insulation.	SF		
*** {Severity L}			
b. Missing or damaged insulation.	SF		
*** {Severity H}			

32.01 CHILLERS - ABSORPTION

COMPONENTS (Continued)

◆ **32.01.01 CHILLERS (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion.**			
Observation:			
a. Surface corrosion no pitting evident.	SF		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	SF		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	SF		
*** {Severity H}			

32.01 CHILLERS - ABSORPTION

COMPONENTS (Continued)

◆ 32.01.02 PUMPS

Pumps are used to cycle the refrigerant from the evaporator catch basin to spray nozzles in the evaporator and to send solution from the generator to the absorber spray nozzles.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Defective pump.**			
Observation:			
a. Leaking at pump, fittings or seals.	EA		
*** {Severity M}			
b. Cracked or damaged pump housing.	EA		
*** {Severity H}			
*** Excessive noise and vibration.**			
Observation:			
a. Rattling noise.	EA	3	
*** {Severity M}			
b. Grinding noise, indicating metal to metal contact.	EA	3	
*** {Severity H}			
*** Defective motor.**			
Observation:			
a. Cracked/damaged housing or end bells.	EA		
*** {Severity H}			
b. Grinding noise, indicating metal to metal contact.	EA		
*** {Severity H}			
c. Electrical arcing noise.	EA		
*** {Severity H}			
*** Defective electrical connectors.**			
Observation:			
a. Loose conduit or connectors.	EA		
*** {Severity M}			
b. Exposed wires or missing cover plates.	EA		
*** {Severity H}			

32.01 CHILLERS - ABSORPTION

COMPONENTS (Continued)

◆ 32.01.03 PURGE UNITS

The purge unit removes the non-condensable gases that enter the refrigerant system through charging or through leaks during normal low pressure operations.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Leakage.**			
Observation:			
a. Evidence of absorbent leakage.	EA	4	
*** {Severity H}			
*** Defective electrical connectors.**			
Observation:			
a. Loose conduit or connectors.	EA		
*** {Severity M}			
b. Exposed wires or missing cover plates.	EA		
*** {Severity H}			
*** Defective mounting bolts.**			
Observation:			
a. Loose mounting bolts.	EA		
*** {Severity M}			
b. Broken or missing mounting bolts.	EA		
*** {Severity H}			

32.01 CHILLERS - ABSORPTION

COMPONENTS (Continued)

◆ 32.01.04 PIPING, FITTINGS AND VALVES

Piping, fittings and valves, that are part of an absorption chiller, pertain to the refrigerant and lubricating oil circuits.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Leaking/damaged fittings.**			
Observation:			
a. Bent or cracked fitting, not leaking.	EA		
*** {Severity L}			
b. Absorbent leaking.	EA	5	
*** {Severity H}			
*** Leaking/damaged pipe.**			
Observation:			
a. Bent or cracked pipe, not leaking.	LF		
*** {Severity L}			
b. Absorbent leaking.	LF	5	
*** {Severity H}			
*** Leaking/damaged valves.**			
Observation:			
a. Broken or missing valve handle.	EA		
*** {Severity L}			
b. Bent stem.	EA		
*** {Severity M}			
c. Leaking valve packing glands/gaskets.	EA	5	
*** {Severity M}			
d. Cracked valve body.	EA		
*** {Severity H}			
*** Defective insulation.**			
Observation:			
a. Loose insulation.	LF		
*** {Severity L}			
b. Missing or damaged insulation.	LF		
*** {Severity H}			

32.01 CHILLERS - ABSORPTION

COMPONENTS (Continued)

◆ 32.01.04 PIPING, FITTINGS AND VALVES (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corroded piping, fittings and valves.**			
Observation:			
a. Surface corrosion no pitting evident.	LF		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	LF		
*** {Severity M}			
c. Corrosion evidenced by holes or loss or base metal.	LF		
*** {Severity H}			

32.01 CHILLERS - ABSORPTION

COMPONENTS (Continued)

◆ 32.01.05 CONTROLS AND INSTRUMENTATION

Controls govern the operation of the chiller and instrumentation shows the status of the chiller components.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Physically damaged control/instrument panel.**			
Observation:			
a. Panel blocked, not accessible for inspection.	EA		
*** {Severity S}			
b. Burned out pilot lamps.	EA		
*** {Severity F}			
c. Physically damaged panel.	EA		
*** {Severity M}			
*** Defective control/instrument.**			
Observation:			
a. Broken/physically damaged.	EA		
*** {Severity M}			
b. Inoperable/missing.	EA		
*** {Severity H}			
*** Damaged mounting hardware or supports.**			
Observation:			
a. Loose mounting hardware or supports.	EA		
*** {Severity M}			
b. Broken or missing hardware or supports.	EA		
*** {Severity H}			

32.01 CHILLERS - ABSORPTION

REFERENCES

1. NAVFAC MO-322, Vol. 2, Inspection of Shore Facilities, 1993
2. Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC, 1988
3. TRANE ABDL-M-1, Operation/Maintenance, Direct-Fired Absorption Chiller
4. CARRIER 1992/1993, Products and Systems Master Catalog
5. 1992 ASHRAE Handbook, Heating, Ventilating and Air-Conditioning Systems and Equipment
6. Refrigeration and Air-Conditioning, Second Edition, Billy C. Langley, Reston Publishing Company, Inc. 1982
7. Electricity for Refrigeration, Heating and Air-Conditioning, Second Edition, Russell E. Smith, Breton Publishers, 1983

32.01 CHILLERS - ABSORPTION

LEVEL II KEYS	GUIDE SHEET CONTROL NUMBER
1	GS-II 32.01.01-1
2	GS-II 32.01.01-2
3	GS-II 32.01.02-3
4	GS-II 32.01.03-4
5	GS-II 32.01.04-5

LEVEL III KEYS	GUIDE SHEET CONTROL NUMBER
1*	GS-III 32.01.01-1*
2*	GS-III 32.01.01-2*
3*	GS-III 32.01.02-3*

* Indicates guide sheets which are not directly referenced by a Key. These are "triggered" by information beyond the inspection process such as time, age or repeated service calls.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 1

COMPONENT: CHILLERS
CONTROL NUMBER: GS-II 32.01.01-1

Application

This guide applies to the investigation of rattling and grinding (metal to metal) noise from the burner/blower.

For fans, blowers and blower assemblies in general use, Level I and II inspection methods will apply. No Level III inspection will be required.

The Facility Manager will specify the level of inspection required for specialized fans, blowers or blower assemblies.

Special Safety Requirements

The following is a list of special safety requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Observe operation and determine possible source of noise.
2. Shut down, tag and lock out disconnect.
3. Remove access plates.
4. Check assembly for wear, damage or loose fasteners.
5. Visually inspect blower blades for foreign objects and deposit buildup.
6. Inspect blower blades for cracks, fatigue, physical damage and corrosion.
7. Rotate shafting and check for distortion in shaft.
8. Rotate to check for binding.
9. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.
10. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.
11. Ensure all guards and covers have been installed; remove tags, lockout on disconnect and restore unit to service.

Recommended Inspection Frequency

Perform inspection when triggered by a Level I or other local factors such as problematic conditions.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 1 (Continued)

COMPONENT: CHILLERS
CONTROL NUMBER: GS-II 32.01.01-1

References

1. Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC, 1988

2. NAVFAC MO-114, Vol.3, Maintenance and Operations of Ventilation Systems, 1989

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 2

COMPONENT: CHILLERS
CONTROL NUMBER: GS-II 32.01.01-2

Application

This guide applies to the investigation of absorbent leaks.

Special Safety Requirements

No special safety requirements are needed for the performance of the Level II inspection beyond those listed in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Check for absorbent leaks at access panel and connection seals using electronic leak detector.
2. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.

Recommended Inspection Frequency

Perform inspection when triggered by a Level I inspection or other local factors such as problematic conditions.

References

1. NAVFAC MO-322, Vol.2, Inspection of Shore Facilities, 1993

2. Modern Refrigeration and Air Conditioning, The Goodheart-Wilcox Company Inc, 1968.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 3

COMPONENT: PUMPS
CONTROL NUMBER: GS-II 32.01.02-3

Application

This guide applies to the investigation of rattling and grinding (metal to metal) noise from the pump.

For pumps in general use, Level I, II & III inspection methods will apply in accordance with the following gallon-per-minute ranges:

a. Use Level I inspection method if GPM is less than 40.
b. Use Level I, II and/or III inspection methods if GPM is 40 or greater.

The Facility Manager will specify the level of inspection required for specialized pump applications.

Special Safety Requirements

The following is a list of special safety requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Observe pump operation and determine possible source of noise.
2. Shut down pump, tag and lock out disconnect.
3. Check coupling for wear, damage or loose fasteners.
4. Examine drives for alignment.
5. Turn pump by hand and determine what is causing the noise.
6. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.
7. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.
8. Ensure all guards and covers have been installed; remove tags, lockout on disconnect and restore unit to service.

Recommended Inspection Frequency

Perform inspection when triggered by a Level I or other local factors such as problematic conditions.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 3 (Continued)

COMPONENT: PUMPS
CONTROL NUMBER: GS-II 32.01.02-3

References

1. Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC, 1988

2. NAVFAC MO-209, Maintenance of Steam, Hot Water and Compressed Air Distribution Systems, 1989

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 4

COMPONENT: PURGE UNITS
CONTROL NUMBER: GS-II 32.01.03-4

Application

This guide applies to the investigation of absorbent leaks.

Special Safety Requirements

No special safety requirements are needed for the performance of the Level II inspection beyond those listed in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Check for absorbent leaks at purge units, using electronic leak detector.
2. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.

Recommended Inspection Frequency

Perform inspection when triggered by a Level I inspection or other local factors such as problematic conditions.

References

1. NAVFAC MO-322, Vol.3, Inspection of Shore Facilities, 1993

2. Modern Refrigeration and Air Conditioning, The Goodheart-Wilcox Company Inc, 1968.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 5

COMPONENT: PIPING, FITTINGS AND VALVES
CONTROL NUMBER: GS-II 32.01.04-5

Application

This guide applies to the investigation of absorbent leaks.

Special Safety Requirements

No special safety requirements are needed for the performance of the Level II inspection beyond those listed in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Check for absorbent leaks at piping, fittings and valves using electronic leak detector.
2. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.

Recommended Inspection Frequency

Perform inspection when triggered by a Level I inspection or other local factors such as problematic conditions.

References

1. NAVFAC MO-322, Vol.2, Inspection of Shore Facilities, 1993

2. Modern Refrigeration and Air Conditioning, The Goodheart-Wilcox Company Inc, 1968.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1*

COMPONENT: CHILLERS
CONTROL NUMBER: GS-III 32.01.01-1*

Application

This guide applies to sampling of lithium bromide for presence of corrosion products and to determine chemical balance of solution inhibitors. Do not duplicate this effort if it is being performed under an existing base PM or recurring maintenance program.

Special Safety Requirements

No special safety requirements are needed for the performance of the Level III inspection beyond those listed in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Acquire a 50 ML sample of the lithium bromide.
2. Perform analysis of the sample to determine presence of corrosion products and chemical balance of solution inhibitors.

Special Tools and Equipment

The following is a list of special tools and equipment, beyond the requirements listed in the Standard Tool Section.

1. 50 ML container

Recommended Inspection Frequency

Annually

References

1. The Locomotive, Hartford Steam Boiler Inspection and Insurance Co., Vol. 66, Spring 1988

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2*

COMPONENT: CHILLERS
CONTROL NUMBER: GS-III 32.01.01-2*

Application

This guide applies to checking of tubes in the condenser, evaporator and absorber to detect deterioration which could lead to tube failure. Do not duplicate this effort if it is being performed under an existing base PM or recurring maintenance program.

Special Safety Requirements

The following is a list of special safety requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Shut down chiller, tag and lock out disconnect.
2. Drain evaporator, absorber and condenser water sides.
3. Open end covers, perform eddy current tests in tubes and chart tube conditions.
4. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.
5. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.
6. Ensure all covers have been installed; remove tags, lockout on disconnect and restore unit to service.

Special Tools and Equipment

The following is a list of special tools and equipment, beyond the requirements listed in the Standard Tool Section.

1. Multi-frequency signal generator
2. Cathode ray tube
3. Oscilloscope
4. Strip chart recorder
5. Eddy current probe

Recommended Inspection Frequency

Every 3 years

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2* (Continued)

COMPONENT: CHILLERS
CONTROL NUMBER: GS-III 32.01.01-2*

References

1. TRANE ABDL-M-1, Operation/Maintenance, Direct-Fired Absorption Chiller

2. NASA Facilities Maintenance Handbook, NHB08831,2, December 1991

3. The Locomotive, Hartford Steam Boiler Inspection and Insurance Co., Vol.66, Spring 1988

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3*

COMPONENT: PUMPS
CONTROL NUMBER: GS-III 32.01.02-3*

Application

This guide applies to the investigation of worn bearings, seals and impellers of the solution pumps. Do not duplicate this effort if it is being performed under an existing base PM or recurring maintenance program.

Special Safety Requirements

The following is a list of special safety requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Shut down pump, tag and lock out disconnect.
2. Isolate pump by securing shutoff valves.
3. Measure run-out play in bearings due to wear; compare with manufacturer's specifications.
4. Check coupling for wear, damage, loose fasteners.
5. Check impellers for wear, erosion/corrosion, physical damage, distortion.
6. Check clearances between impeller and wear rings; compare with manufacturer's specifications.
7. Document the problem and contact appropriate facility personnel for further instructions and reassemble pump, if directed.
8. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.
9. Ensure all guards and covers have been installed; remove tags, lockout on disconnect and restore unit to service.

Special Tools and Equipment

No special safety requirements are needed for the performance of the Level III inspection beyond the requirements listed in Standards Tools Section, otherwise every 3 years.

Recommended Inspection Frequency

Follow manufacturers recommendations for frequency of inspection of the pump assembly. If there is no manufacturer's recommendation an inspection should be performed on a three year cycle or whenever the desired degree of reliability justifies the procedure.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3* (Continued)

COMPONENT: PUMPS
CONTROL NUMBER: GS-III 32.01.02-3*

References

1. The Locomotive, Hartford Steam Boiler Inspection and Insurance Co., Vol. 66, Spring 1988

32.02 CHILLERS - CENTRIFUGAL

DESCRIPTION

Chillers - Centrifugal is a subsystem of the Central Cooling Plant. A centrifugal chiller compresses gaseous refrigerant using centrifugal force and produces cooling via water, through a shell and tube evaporator.

SPECIAL TOOL AND EQUIPMENT REQUIREMENTS

The following special tools and equipment are needed for the inspection of Chillers - Centrifugal , beyond the requirements listed in the Standard Tools Section.

1. Electronic Leak Detector

SPECIAL SAFETY REQUIREMENTS

No special safety requirements are needed for the inspection of Chillers - Centrifugal , beyond the requirements listed in the Master Safety Plan and System Safety Section.

COMPONENT LIST

- 32.02.01 CHILLERS
- 32.02.02 PURGE UNITS
- 32.02.03 PIPING, FITTINGS AND VALVES
- 32.02.04 CONTROLS AND INSTRUMENTATION

RELATED SUBSYSTEMS

Due to the related nature of the elements requiring inspection, the following subsystems should be reviewed for concurrent inspection activities.

32.05 CHILLED WATER DISTRIBUTION SYSTEMS
32.06 CONDENSER WATER DISTRIBUTION SYSTEMS

32.02 CHILLERS - CENTRIFUGAL

STANDARD INSPECTION PROCEDURE

This subsystem requires both Level I and Level II inspection as part of the basic inspection process. Additional Level II inspections may be indicated or "triggered" by the Level I inspection observation and should be accomplished by the inspector at that time.

For electric motors in general use, Level I, II & III inspection methods will apply in accordance with the following horsepower ranges:

a. Use Level I inspection method if HP is less than 15.
b. Use Level II inspection method if HP is 15 to 60.
c. Use Level III inspection method if HP is 60 or greater.

The Facility Manager will specify the level of inspection required for specialized pump and motor applications.

Associated defects and observations, for each major component, are listed in the inspectors' Data Collection Devices.

COMPONENTS

◆ 32.02.01 CHILLERS

The chiller consists of a centrifugal compressor, compressor motor, water cooled condenser, economizer, heat recovery unit, evaporator and lubrication system.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Excessive noise and vibration at the compressor.**			
Observation:			
a. Rattling noise.	EA		1
*** {Severity M}			
b. Grinding noise indicating metal to metal contact.	EA		1
*** {Severity H}			
*** Excessive noise and vibration at the motor.**			
Observation:			
a. Rattling noise.	EA		2
*** {Severity M}			
b. Grinding noise indicating metal to metal contact.	EA		2
*** {Severity H}			

32.02 CHILLERS - CENTRIFUGAL

COMPONENTS (Continued)

◆ 32.02.01 CHILLERS (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Leakage.**			
Observation:			
a. Evidence of water leakage.	EA		
*** {Severity M}			
b. Evidence of refrigerant leakage.	EA	1	
*** {Severity H}			
*** Defective electrical connectors.**			
Observation:			
a. Loose conduit or connectors.	EA		
*** {Severity M}			
b. Exposed wires or missing cover plates.	EA		
*** {Severity H}			
*** Defective assembly hardware.**			
Observation:			
a. Loose assembly bolts.	EA		
*** {Severity M}			
b. Broken/missing assembly bolts.	EA		
*** {Severity H}			
*** Defective mounting hardware.**			
Observation:			
a. Loose base tie-down bolts.	EA		
*** {Severity M}			
b. Missing base tie-down bolts.	EA		
*** {Severity H}			
*** Defective insulation.**			
Observation:			
a. Loose insulation.	SF		
*** {Severity L}			
b. Missing or damaged insulation.	SF		
*** {Severity H}			

32.02 CHILLERS - CENTRIFUGAL

COMPONENTS (Continued)

◆ **32.02.01 CHILLERS (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
* **Corrosion.**			
Observation:			
a. Surface corrosion no pitting evident.	SF		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	SF		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	SF		
*** {Severity H}			

32.02 CHILLERS - CENTRIFUGAL

COMPONENTS (Continued)

◆ 32.02.02 PURGE UNITS

The purge unit removes the non-condensable gases that enter the refrigerant system through charging or leaks during normal low pressure operations.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Leakage.**			
Observation:			
a. Evidence of refrigerant leakage.	EA	2	
*** {Severity H}			
*** Defective electrical connectors.**			
Observation:			
a. Loose conduit or connectors.	EA		
*** {Severity M}			
b. Exposed wires or missing cover plates.	EA		
*** {Severity H}			
*** Defective mounting bolts.**			
Observation:			
a. Loose mounting bolts.	EA		
*** {Severity M}			
b. Broken or missing mounting bolts.	EA		
*** {Severity H}			

32.02 CHILLERS - CENTRIFUGAL

COMPONENTS (Continued)

◆ 32.02.03 PIPING, FITTINGS AND VALVES

Piping, fittings and valves, that are part of the centrifugal chiller, provide the refrigerant and lubricating oil circuits.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Leaking/damaged fittings.**			
Observation:			
a. Bent or cracked fitting, not leaking.	EA		
*** {Severity L}			
b. Evidence of oil leaking.	EA		
*** {Severity H}			
c. Evidence of refrigerant leaking.	EA	3	
*** Severity H}			
*** Leaking/damaged pipe.**			
Observation:			
a. Bent or cracked pipe, not leaking.	LF		
*** {Severity L}			
b. Evidence of oil leaking.	LF		
*** {Severity H}			
c. Evidence of refrigerant leaking.	LF	3	
*** {Severity H}			
*** Leaking/damaged valves.**			
Observation:			
a. Broken or missing valve handle.	EA		
*** {Severity L}			
b. Bent stem.	EA		
*** {Severity M}			
c. Cracked valve body.	EA		
*** {Severity H}			
d. Evidence of oil leaking.	EA		
*** {Severity H}			
e. Evidence of refrigerant leaking.	EA	3	
*** {Severity H}			
*** Defective insulation.**			
Observation:			
a. Loose insulation.	LF		
*** {Severity L}			
b. Damaged or missing insulation.	LF		
*** {Severity H}			

32.02 CHILLERS - CENTRIFUGAL

COMPONENTS (Continued)

◆ **32.02.03 PIPING, FITTINGS AND VALVES (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corroded piping, fittings and valves**			
Observation:			
a. Surface corrosion no pitting evident.	LF		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	LF		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	LF		
*** {Severity H}			

32.02 CHILLERS - CENTRIFUGAL

COMPONENTS (Continued)

◆ 32.02.04 CONTROLS AND INSTRUMENTATION

Controls govern the operation of the chiller and instrumentation shows the status of the chiller components.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Physically damaged control/instrument panel.**			
Observation:			
a. Panel blocked, not accessible for inspection.	EA		
*** {Severity S}			
b. Burned out pilot lamps.	EA		
*** {Severity F}			
c. Physically damaged panel.	EA		
*** {Severity M}			
*** Defective control/instrument.**			
Observation:			
a. Broken/physically damaged.	EA		
*** {Severity M}			
b. Inoperable/missing.	EA		
*** {Severity H}			
*** Damaged mounting hardware or supports.**			
Observation:			
a. Loose mounting hardware or supports.	EA		
*** {Severity M}			
b. Broken or missing hardware or supports.	EA		
*** {Severity H}			

32.02 CHILLERS - CENTRIFUGAL

REFERENCES

1. NAVFAC MO-322, Vol.2, Inspection of Shore Facilities, 1993
2. Means Facilities Maintenance Standards, Roger W. Liska, P.E., AIC, 1988
3. TRANE CVHB0M05A, Operation/Maintenance Centrifugal Chiller
4. CARRIER 1992/1993, Products and Systems Master Catalog
5. Operation and Maintenance of Centrifugal Units by Garth Denison CMS
6. 1992 ASHRAE Handbook, Heating, Ventilating and Air-Conditioning Systems and Equipment
7. Refrigeration and Air-Conditioning, Second Edition, Billy C. Langley, Reston Publishing Company, Inc. 1982
8. Electricity for Refrigeration, Heating and Air-Conditioning, Second Edition, Russell E. Smith, Breton Publishers, 1983

32.02 CHILLERS - CENTRIFUGAL

LEVEL II KEYS	GUIDE SHEET CONTROL NUMBER
1	GS-II 32.02.01-1
2	GS-II 32.02.02-2
3	GS-II 32.02.03-3

LEVEL III KEYS	GUIDE SHEET CONTROL NUMBER
1	GS-III 32.02.01-1
2	GS-III 32.02.01-2
3*	GS-III 32.02.01-3*
4*	GS-III 32.02.01-4*
5*	GS-III 32.02.01-5*
6*	GS-III 32.02.01-6*
7*	GS-III 32.02.01-7*

* Indicates guide sheets which are not directly referenced by a Key. These are "triggered" by information beyond the inspection process such as time, age or repeated service calls.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 1

COMPONENT: CHILLERS
CONTROL NUMBER: GS-II 32.02.01-1

Application

This guide applies to the investigation of refrigerant leaking at chiller.

Special Safety Requirements

No special safety requirements are needed for the performance of the Level II inspection beyond those listed in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Check for refrigerant leak at gaskets, sight glass and shut-off valves.
2. Check chiller for cracks in the body.
3. Check for leaks at the compressor terminals.
4. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.

Recommended Inspection Frequency

Perform inspection when triggered by a Level I inspection or other local factors such as problematic conditions.

References

1. NAVFAC MO-322, Vol.2, Inspection of Shore Facilities, 1993

2. Modern Refrigeration and Air Conditioning, The Goodheart-Wilcox Company Inc.,1968

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 2

COMPONENT: PURGE UNITS
CONTROL NUMBER: GS-II 32.02.02-2

Application

This guide applies to the investigation of refrigerant leaking at purge unit.

Special Safety Requirements

No special safety requirements are needed for the performance of the Level II inspection beyond those listed in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Check for refrigerant leaks at purge units using electronic leak detector.
2. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.

Recommended Inspection Frequency

Perform inspection when triggered by a Level I inspection or other local factors such as problematic conditions.

References

1. NAVFAC MO-322, Vol.2, Inspection of Shore Facilities, 1993

2. Modern Refrigeration and Air Conditioning, The Goodheart-Wilcox Company Inc.,1968

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 3

COMPONENT: PIPING, FITTINGS AND VALVES
CONTROL NUMBER: GS-II 32.02.03-3

Application

This guide applies to the investigation of refrigerant leaking at the piping, fittings and valves.

Special Safety Requirements

No special safety requirements are needed for the performance of the Level II inspection beyond those listed in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Check piping, fittings and valves for refrigerant leaks using electronic leak detector.
2. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.

Recommended Inspection Frequency

Perform inspection when triggered by a Level I inspection or other local factors such as problematic conditions.

References

1. NAVFAC MO-322, Vol.2, Inspection of Shore Facilities, 1993

2. Modern Refrigeration and Air Conditioning, The Goodheart-Wilcox Company Inc.,1968

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1

COMPONENT: CHILLERS
CONTROL NUMBER: GS-III 32.02.01-1

Application

This guide applies to the investigation of rattling and grinding (metal to metal) noise from the centrifugal compressor.

Special Safety Requirements

The following is a list of special safety requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Observe compressor operation and determine possible source of noise.
2. Perform vibration analysis on compressor bearings.
3. Shut down compressor, tag and lock out disconnect.
4. Isolate unit mechanically by pumping down system and securing valves on associated components.
5. Open and inspect compressor interior housing for cracks, fatigue, erosion, and corrosion, check suspicious areas with dye penetrant.
6. Check interior shafting for signs of fatigue.
7. Check compressor shafting for damage from packing/mechanical seal.
8. Check impellers for erosion/corrosion, physical damage, distortion.
9. Rotate (cycle) shafting and check for distortion in shaft.
10. Check clearances between impeller and wear rings; compare with manufacturer's specifications.
11. Close compressor.
12. Rotate (cycle) compressor to check for binding.
13. Measure run-out play in bearings due to wear; compare with manufacturer's specifications.
14. Check coupling for wear, damage, loose fasteners.
15. Check coupling for misalignment.
16. Ensure that all seals and covers have been reinstalled.
17. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.
18. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.
19. Restore valving to normal position.
20. Remove tags, lockout on disconnect and restore unit to service.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1 (Continued)

COMPONENT: CHILLERS
CONTROL NUMBER: GS-III 32.02.01-1

Special Tools and Equipment

The following is a list of special tools and equipment, beyond the requirements listed in the Standard Tool Section.

1. Alignment Tools
2. Vibration Tester
3. Dye Penetrant
4. Refrigerant Gauges

Recommended Inspection Frequency

Perform inspection when triggered by Level I and Level II inspections or other local factors such as problematic conditions.

References

1. NAVFAC MO-322, Vol.2, Inspection of Shore Facilities, 1993
2. Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC 1988
3. TRANE CVHB0M05A, Operation/Maintenance Centrifugal Chiller

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2

COMPONENT: CHILLERS
CONTROL NUMBER: GS-III 32.02.01-2

Application

This guide applies to the investigation of rattling and grinding (metal to metal) noise from the chiller motor.

For electric motors in general use, Level I, II & III inspections methods will apply in accordance with the following horsepower ranges:

1. Use Level I inspection method if HP is less than 15.
2. Use Level I & II inspection method if HP is 15 to 60.
3. Use Level I, II and/or III inspection if HP is 60 or greater.

The Facility Manager will specify the level of inspection required for specialized motor applications.

Special Safety Requirements

The following is a list of special requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Observe motor operation and determine possible source of noise.
2. Perform vibration analysis on motor bearings.
3. Shut down motor, tag and lock out disconnect.
4. Isolate unit mechanically by pumping down system and securing valves on associated components.
5. Rotate (cycle) motor to check for binding.
6. Measure run-out play in bearings due to wear; compare with manufacturer's specifications.
7. Open and inspect motor interior housing for cracks, fatigue, erosion and corrosion, check suspicious areas with dye penetrant.
8. Check interior shafting for signs of fatigue or wear.
9. Rotate (cycle) shafting and check for distortion.
10. Document the problem and contact appropriate facility personnel for further instructions and reassemble motor, if directed.
11. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.
12. Ensure all guards and covers have been installed; evacuate air from system and recharge, remove tags, lockout on disconnect and restore unit to service.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2 (Continued)

COMPONENT: CHILLERS
CONTROL NUMBER: GS-III 32.02.01-2

Special Tools and Equipment

The following is a list of special tools and equipment beyond those listed in the Standard Tool Section.

1. Alignment Tools
2. Vibration Tester
3. Dye Penetrant

Recommended Inspection Frequency

Perform inspection when triggered by Level I and Level II inspections or other local factors such as problematic conditions.

References

1. Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC, 1988

2. Electric Motor & Contracting Co., Inc., Chesapeake, VA

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3*

COMPONENT: CHILLERS
CONTROL NUMBER: GS-III 32.02.01-3*

Application

This guide applies to checking the windings of electric motors for open circuits, grounds or deteriorated insulation. Do not duplicate this effort if it is being performed under an existing base PM or recurring maintenance program.

Special Safety Requirements

The following is a list of special requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.
2. Large electrical equipment such as motors above 500 HP usually have sufficient capacitance to store a dangerous amount of energy from the test current. Make sure this capacitance is discharged after each test and before handling the test leads.
3. Do not use the megohmmeter in an explosive atmosphere.

Inspection Actions

1. Check line voltage and ampere load for proper balance.
2. Shut down motor, tag and lockout disconnect.
3. Remove the three phase leads (load conductors) at the motor terminals or at the starter. If leads are removed at the motor, tape conductor ends. Mark leads.
4. Perform grounding and dielectric resistance test on motor windings. Values below 50 Megohms at an ambient temperature of 85 degrees F or less may indicate the presence of moisture in the winding insulation.
5. Document readings and contact appropriate facility personnel if the readings indicate a suspected problem.
6. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.
7. Make sure that leads are connected and covers have been installed; remove tags, lockout on disconnect and restore unit to service.

Special Tools and Equipment

The following is a list of special tools and equipment beyond those listed in the Standard Tool Section.

1. Megohmmeter

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3* (Continued)

COMPONENT: CHILLERS
CONTROL NUMBER: GS-III 32.02.01-3*

Recommended Inspection Frequency

Annually

References

1. The Locomotive, Vol. 69, Spring 1994, The Hartford Steam Boiler Inspection and Insurance Co., Inc.

2. Institute of Electrical and Electronic Engineers (IEEE), Specifications 112 (1984), 113 (1985) and 115 (1983)

3. National Electrical Manufactures' Association (NEMA) Book, MG 1-987, Part 12 (1987)

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 4*

COMPONENT: CHILLERS
CONTROL NUMBER: GS-III 32.02.01-4*

Application

This guide applies to the sampling of the chiller oil to determine the oil degradation, oil contamination and machine wear. Do not duplicate this effort if it is being performed under an existing base PM or recurring maintenance program.

Special Safety Requirements

Special safety requirements are needed for the performance of the Level III inspection beyond those listed in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Acquire a 50 ML sample of the chiller oil.
2. Perform a spectrochemical analysis of the oil sample to determine the oil degradation, oil contamination and machine wear.

Special Tools and Equipment

The following is a list of special tools and equipment beyond those listed in the Standard Tool Section.

1. 50 ML container

Recommended Inspection Frequency

Annually

References

1. Jennings Laboratories, 1118 Cypress Ave., Virginia Beach, VA
2. Operation and Maintenance of Centrifugal Units by Garth Denison CMS
3. The Locomotive, Hartford Steam Boiler Inspection and Insurance Co., Vol. 66, Spring 1988

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 5*

COMPONENT: CHILLERS
CONTROL NUMBER: GS-III 32.02.01-5*

Application

This guide applies to the checking of the tubes in the condenser and evaporator for refrigerant leaks. Do not duplicate this effort if it is being performed under an existing base PM or recurring maintenance program.

Special Safety Requirements

The following is a list of special safety requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Shut down chiller, tag and lock out disconnect.
2. Isolate unit mechanically by pumping down system and securing valves on associated components.
3. Open end covers and inspect condition of tubes, check for refrigerant leaks using a dye penetrant on suspicious areas.
4. Replace end covers.
5. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.
6. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.
7. Restore valving to normal position.
8. Remove tags, lockout on disconnect and restore unit to service.

Special Tools and Equipment

The following is a list of special tools and equipment, beyond the requirements listed in the Standard Tool Section.

1. Dye Penetrant
2. Refrigerant Gauges

Recommended Inspection Frequency

Annually

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 5* (Continued)

COMPONENT: CHILLERS
CONTROL NUMBER: GS-III 32.02.01-5*

References

1. NAVFAC MO-322, Vol.2, Inspection of Shore Facilities, 1993
2. Means Facilities Maintenance Standards, Roger W. Liska, P.E., AIC, 1988
3. TRANE CVHB0M05A, Operation/Maintenance Centrifugal Chiller
4. Operation and Maintenance of Centrifugal Units by Garth Denison CMS

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 6*

COMPONENT: CHILLERS
CONTROL NUMBER: GS-III 32.02.01-6*

Application

This guide applies to the disassembly of the compressor for inspection. Do not duplicate this effort if it is being performed under an existing base PM or recurring maintenance program.

Special Safety Requirements

The following is a list of special safety requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Shut down chiller, tag and lock out disconnect.
2. Isolate compressor mechanically by pumping down system and securing valves on associated components.
3. Perform a nondestructive test of the internal parts of the compressor, according to the manufacturers recommendations.
4. Re-assemble the compressor.
5. Document any problems and contact appropriate facility personnel for further instructions.
6. Notify appropriate facility personnel for permission to place unit back in service if defects found are not critical to continued function.
7. Restore valving to normal position.
8. Remove tags, lockout on disconnect and restore unit to service.

Special Tools and Equipment

The following is a list of special tools and equipment, beyond the requirements listed in the Standard Tool Section.

1. Alignment Tools
2. Vibration Tester
3. Dye Penetrant
4. Refrigerant Gauges

Recommended Inspection Frequency

Every 5 years or 40,000 hours of operation

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 6* (Continued)

COMPONENT: CHILLERS
CONTROL NUMBER: GS-III 32.02.01-6*

References

1. NAVFAC MO-322, Vol.2, Inspection of Shore Facilities, 1993
2. Means Facilities Maintenance Standards, Roger W. Liska, P.E., AIC, 1988
3. CARRIER CORP, Catalogs 19.011, Forms 19EB-3SSM
4. TRANE CVHB0M05A, Operation/Maintenance Centrifugal Chiller
5. Operation and Maintenance of Centrifugal Units by Garth Denison CMS

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 7*

COMPONENT: CHILLERS
CONTROL NUMBER: GS-III 32.02.01-7*

Application

This guide applies to checking tubes in the condenser and evaporator to detect deterioration which could lead to tube failure. Do not duplicate this effort if it is being performed under an existing base PM or reoccurring maintenance program.

Special Safety Requirements

The following is a list of special safety requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Shut down condenser, tag and lock disconnect.
2. Drain condenser and evaporator water sides.
3. Open end covers, perform eddy current tests in tubes and chart tube conditions..
4. Document the problem and contact appropriate facility personnel for further instructions, if defects cannot be determined or is major.
5. Notify appropriate facility personnel for permission to place unit back in service if defects found are not critical to continued function.
6. Ensure all covers have been installed; remove tags, disconnect and restore unit to service.

Special Tools and Equipment

The following is a list of special tools and equipment, beyond the requirements listed in the Standard Tool Section.

1. Multi-frequency signal generator
2. Cathode ray tube
3. Oscilloscope
4. Strip chart recorder
5. Eddy current probe

Recommended Inspection Frequency

Every 3 years.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 7* (Continued)

COMPONENT: CHILLERS
CONTROL NUMBER: GS-III 32.02.01-7*

References

1. NAVFAC MO-322, Vol.2, Inspection of Shore Facilities, 1993

2. Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC, 1988.

3. Modern Refrigeration and Air Conditioning, The Goodheart-Wilcox Company Inc.,1968

4. The Locomotive, The Hartford Steam Boiler Inspection and Insurance Co., Spring 1988, Vol. 66

32.03 CHILLERS - RECIPROCATING

DESCRIPTION

Chillers - Reciprocating is a subsystem of the Central Cooling Plant. A reciprocating chiller compresses gaseous refrigerant using a reciprocating piston force and produces cooling via water, through a shell and tube evaporator.

SPECIAL TOOL AND EQUIPMENT REQUIREMENTS

The following list of special tools and equipment, beyond the requirements listed in the Standard Tool Section, are required to perform the inspection of the Chillers - Reciprocating Systems:

1. Electronic Leak Detector

SPECIAL SAFETY REQUIREMENTS

No special safety requirements are needed for the inspection of Chillers - Reciprocating Systems, beyond the requirements listed in the Master Safety Plan and System Safety Section.

COMPONENT LIST

- 32.03.01 ENCLOSURES AND SUPPORTS
- 32.03.02 COMPRESSORS
- 32.03.03 CONDENSERS - AIR COOLED
- 32.03.04 CONDENSERS - WATER COOLED
- 32.03.05 EVAPORATORS
- 32.03.06 PIPING, FITTINGS AND VALVES
- 32.03.07 CONTROLS AND INSTRUMENTATION

RELATED SUBSYSTEMS

Due to the related nature of the elements requiring inspection, the following subsystems should be reviewed for concurrent inspection activities.

32.05 CHILLED WATER DISTRIBUTION SYSTEMS
32.06 CONDENSER WATER DISTRIBUTION SYSTEMS

32.03 CHILLERS - RECIPROCATING

STANDARD INSPECTION PROCEDURE

This subsystem requires both Level I and Level II inspection as part of the basic inspection process. Additional Level II inspections may be indicated or "triggered" by the Level I inspection observation and should be accomplished by the inspector at that time.

For electric motors in general use, Level I, II & III inspection methods will apply in accordance with the following horsepower ranges:

a. Use Level I inspection method if HP is less than 15.
b. Use Level II inspection method if HP is 15 to 60.
c. Use Level III inspection method if HP is 60 or greater.

The Facility Manager will specify the level of inspection required for specialized motor applications.

Associated defects and observations, for each major component, are listed in the inspectors' Data Collection Devices.

COMPONENTS

◆ 32.03.01 ENCLOSURES AND SUPPORTS

The enclosure is the housing for reciprocating chillers. Supports are the structural members that support the main chiller components.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Damaged enclosure panels.**			
Observation:			
a. Loose enclosure panel.	EA		
*** {Severity L}			
b. Missing or damaged enclosure panel.	EA		
*** {Severity H}			
*** Defective mounting hardware or supports.**			
Observation:			
a. Loose hardware or supports.	EA		
*** {Severity L}			
b. Missing or damaged hardware or supports.	EA		
*** {Severity H}			

32.03 CHILLERS - RECIPROCATING

COMPONENTS (Continued)

◆32.03.01 ENCLOSURES AND SUPPORTS (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corroded enclosure panels.**			
Observation:			
a. Surface corrosion no pitting evident.	SF		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	SF		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	SF		
*** {Severity H}			
*** Corroded supports.**			
Observation:			
a. Surface corrosion no pitting evident.	EA		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	EA		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	EA		
*** {Severity H}			

32.03 CHILLERS - RECIPROCATING

COMPONENTS (Continued)

◆ 32.03.02 COMPRESSORS

The compressor consists of a motor driven compressor unit that compresses the refrigerant.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Leakage.**			
Observation:			
a. Evidence of refrigerant leakage.	EA	1	
*** {Severity H}			
*** Excessive noise or vibration at compressor.**			
Observation:			
a. Rattling noise.	EA		1
*** {Severity M}			
b. Grinding noise, indicating metal to metal contact.	EA		1
*** {Severity H}			
*** Defective mounting hardware.**			
Observation:			
a. Loose base tie-down bolts.	EA		
*** {Severity M}			
b. Missing base tie-down bolts or isolators.	EA		
*** {Severity H}			
*** Corrosion.**			
Observation:			
a. Surface corrosion no pitting evident.	SF		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	SF		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	SF		
*** {Severity H}			

32.03 CHILLERS - RECIPROCATING

COMPONENTS (Continued)

◆ 32.03.03 CONDENSERS - AIR COOLED

The air cooled condensers consist of propeller fans and fin-tube heat exchangers. The condensers serve to liquify the high pressure refrigerant gas.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Leakage.**			
Observation:			
a. Evidence of refrigerant leakage.	EA	2	
*** {Severity H}			
*** Deteriorated/clogged coils.**			
Observation:			
a. Dust/debris accumulation on coils.	SF		
*** {Severity F}			
b. Damaged coils.	SF		
*** {Severity H}			
*** Excessive noise or vibration in fan motor.**			
Observation:			
a. Clicking or rattling noise.	EA		
*** {Severity M}			
b. Grinding noise, indicating metal to metal contact.	EA		
*** {Severity H}			
*** Defective fan blade.**			
Observation:			
a. Fan blade hitting metal housing.	EA		
*** {Severity M}			
b. Cracked or damaged fan blades.	EA		
*** {Severity H}			
*** Defective fan motor mounting hardware or supports.**			
Observation:			
a. Loose hardware or supports.	EA		
*** {Severity L}			
b. Missing or damaged hardware or supports.	EA		
*** {Severity H}			

32.03 CHILLERS - RECIPROCATING

COMPONENTS (Continued)

◆ **32.03.03 CONDENSERS - AIR COOLED (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corroded condenser coil.**			
Observation:			
a. Surface corrosion no pitting evident.	SF		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	SF		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	SF		
*** {Severity H}			

32.03 CHILLERS - RECIPROCATING

COMPONENTS (Continued)

◆ 32.03.04 CONDENSERS - WATER COOLED

The water cooled condensers consist of shell and tube heat exchangers. The condensers serve to liquify the high pressure refrigerant gas.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Leakage.**			
Observation:			
a. Evidence of water leakage.	EA		
*** {Severity H}			
b. Evidence of refrigerant leakage.	EA	3	
*** {Severity H}			
*** Corroded water cooled condenser.**			
Observation:			
a. Surface corrosion no pitting evident.	SF		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	SF		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	SF		
*** {Severity H}			

32.03 CHILLERS - RECIPROCATING

COMPONENTS (Continued)

◆ 32.03.05 EVAPORATORS

The evaporators consist of shell and tube heat exchangers. The evaporators serve to cool circulating water for the building.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Leakage.**			
Observation:			
a. Evidence of water leakage.	EA		
*** {Severity H}			
b. Evidence of refrigerant leakage.	EA	4	
*** {Severity H}			
*** Defective insulation.**			
Observation:			
a. Loose insulation.	SF		
*** {Severity L}			
b. Damaged or deteriorated insulation.	SF		
*** {Severity M}			
c. Missing insulation.	SF		
*** {Severity H}			
*** Corroded evaporator.**			
Observation:			
a. Surface corrosion no pitting evident.	SF		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	SF		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	SF		
*** {Severity H}			

32.03 CHILLERS - RECIPROCATING

COMPONENTS (Continued)

◆ 32.03.06 PIPING, FITTINGS AND VALVES

Piping, fittings and valves, that are part of the reciprocating chiller, provide the refrigerant and lubricating oil circuits.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Leaking/damaged fittings.**			
Observation:			
a. Bent or cracked fitting, not leaking.	EA		
*** {Severity L}			
b. Evidence of leaking.	EA		
*** {Severity H}			
c. Evidence of refrigerant leaking.	EA	5	
*** {Severity H}			
*** Leaking/damaged pipe.**			
Observation:			
a. Bent or cracked pipe, not leaking.	LF		
*** {Severity L}			
b. Evidence of oil leaking.	LF		
*** {Severity H}			
c. Evidence of refrigerant leaking.	LF	5	
*** {Severity H}			
*** Leaking/damaged valves.**			
Observation:			
a. Broken or missing valve handle.	EA		
*** {Severity L}			
b. Bent stem.	EA		
*** {Severity M}			
c. Cracked valve body.	EA		
*** {Severity H}			
d. Evidence of oil leaking.	EA		
*** {Severity H}			
e. Evidence of refrigerant leaking.	EA	5	
*** {Severity H}			
*** Defective insulation.**			
Observation:			
a. Loose insulation.	LF		
*** {Severity L}			
b. Damaged or missing insulation.	LF		
*** {Severity H}			

32.03 CHILLERS - RECIPROCATING

COMPONENTS (Continued)

◆ **32.03.06 PIPING, FITTINGS AND VALVES (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corroded piping, fittings and valves.**			
Observation:			
a. Surface corrosion no pitting evident.	LF		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	LF		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	LF		
*** {Severity H}			

32.03 CHILLERS - RECIPROCATING

COMPONENTS (Continued)

◆ 32.03.07 CONTROLS AND INSTRUMENTATION

Controls govern the operation of the chiller and instrumentation show the status of the chiller components.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Physically damaged control/instrument panel.**			
Observation:			
a. Panel blocked, not accessible for inspection.	EA		
*** {Severity S}			
b. Burned out pilot lamps.	EA		
*** {Severity F}			
c. Physically damaged panel.	EA		
*** {Severity M}			
*** Defective control/instrument.**			
Observation:			
a. Broken/physically damaged.	EA		
*** {Severity M}			
b. Inoperable or missing.	EA		
*** {Severity H}			
*** Damaged mounting hardware or supports.**			
Observation:			
a. Loose mounting hardware or supports.	EA		
*** {Severity M}			
b. Broken or missing hardware or supports.	EA		
*** {Severity H}			

32.03 CHILLERS - RECIPROCATING

REFERENCES

1. NAVFAC MO-322, Vol.2, Inspection of Shore Facilities, 1993

2. Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC, 1988

3. TRANE CGWC-10M-3, Installation, Operation, Maintenance, Reciprocating Chiller

4. CARRIER 30GB075-200 Flotronic Reciprocating Liquid Chillers

5. 1992 ASHRAE Handbook, Heating, Ventilating and Air-Conditioning Systems and Equipment.

6. Refrigeration and Air-Conditioning, Second Edition, Bill C. Langley, Reston Publishing Co., Inc., 1982

7. Electricity for Refrigeration, Heating and Air-Conditioning, Second Edition, Russell E. Smith, Breton Publishers, 1983

32.03 CHILLERS - RECIPROCATING

LEVEL II KEYS	GUIDE SHEET CONTROL NUMBER
1	GS-II 32.03.02-1
2	GS-II 32.03.03-2
3	GS-II 32.03.04-3
4	GS-II 32.03.05-4
5	GS-II 32.03.06-5

LEVEL III KEYS	GUIDE SHEET CONTROL NUMBER
1	GS-III 32.03.02-1
2*	GS-III 32.03.02-2*
3*	GS-III 32.03.02-3*
4*	GS-III 32.03.02-4*
5*	GS-III 32.03.02-5*
6*	GS-III 32.03.04-6*
7*	GS-III 32.03.04-7*
8*	GS-III 32.03.05-8*
9*	GS-III 32.03.05-9*

* Indicates guide sheets which are not directly referenced by a Key. These are "triggered" by information beyond the inspection process such as time, age or repeated service calls.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 1

COMPONENT: COMPRESSORS
CONTROL NUMBER: GS-II 32.03.02-1

Application

This guide applies to the investigation of refrigerant leaking at the compressor.

Special Safety Requirements

No special safety requirements are needed for the performance of the Level II inspection beyond those listed in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Check compressor for refrigerant leaks at gaskets, sight glass and shut-off valves.
2. Check compressor for cracks in the body.
3. Check for leaks at the compressor terminals.
4. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.

Recommended Inspection Frequency

Perform inspection when triggered by a Level I inspection or other local factors such as problematic conditions.

References

1. NAVFAC MO-322, Vol.2, Inspection of Shore Facilities, 1993

2. Modern Refrigeration and Air Conditioning, The Goodheart-Wilcox Company Inc.,1968

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 2

COMPONENT: CONDENSERS - AIR COOLED
CONTROL NUMBER: GS-II 32.03.03-2

Application

This guide applies to the investigation of refrigerant leaking at the condenser coil.

Special Safety Requirements

No special safety requirements are needed for the performance of the Level II inspections beyond those listed in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Check for refrigerant leak at coil, sight glass and shut-off valves.
2. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.

Recommended Inspection Frequency

Perform inspection when triggered by a Level I inspection or other local factors such as problematic conditions.

References

1. NAVFAC MO-322, Vol.2, Inspection of Shore Facilities, 1993

2. Modern Refrigeration and Air Conditioning, The Goodheart-Wilcox Company Inc.,1968

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 3

COMPONENT: CONDENSERS - WATER COOLED
CONTROL NUMBER: GS-II 32.03.04-3

Application

This guide applies to the investigation of refrigerant leaking at a water cooled condenser.

Special Safety Requirements

No special safety requirements are needed for the performance of the Level II inspections beyond those listed in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Check for refrigerant leak at gaskets, sight glass and shut-off valves.
2. Check for cracks in the condenser body.
3. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.

Recommended Inspection Frequency

Perform inspection when triggered by a Level I inspection or other local factors such as problematic conditions.

References

1. NAVFAC MO-322, Vol.2, Inspection of Shore Facilities, 1993

2. Modern Refrigeration and Air Conditioning, The Goodheart-Wilcox Company Inc.,1968

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 4

COMPONENT: EVAPORATORS
CONTROL NUMBER: GS-II 32.03.05-4

Application

This guide applies to the investigation of refrigerant leaking at the evaporator.

Special Safety Requirements

No special safety requirements are needed for the performance of the Level II inspections beyond those listed in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Check evaporator for refrigerant leaks at gaskets, sight glass and shut-off valves.
2. Check evaporator for cracks in the body.
3. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.

Recommended Inspection Frequency

Perform inspection when triggered by a Level I inspection or other local factors such as problematic conditions.

References

1. NAVFAC MO-322, Vol.2, Inspection of Shore Facilities, 1993

2. Modern Refrigeration and Air Conditioning, The Goodheart-Wilcox Company Inc.,1968

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 5

COMPONENT: PIPING, FITTINGS AND VALVES
CONTROL NUMBER: GS-II 32.03.06-5

Application

This guide applies to the investigation of refrigerant leaking at piping, fittings and valves.

Special Safety Requirements

No special safety requirements are needed for the performance of the Level II inspections beyond those listed in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Check for refrigerant leak at piping, fittings and valves.
2. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.

Recommended Inspection Frequency

Perform inspection when triggered by a Level I inspection or other local factors such as problematic conditions.

References

1. NAVFAC MO-322, Vol.2, Inspection of Shore Facilities, 1993

2. Modern Refrigeration and Air Conditioning, The Goodheart-Wilcox Company Inc.,1968

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1

COMPONENT: COMPRESSORS
CONTROL NUMBER: GS-III 32.03.02-1

Application

This guide applies to the investigation of rattling or grinding noise from the compressors.

Special Safety Requirements

No special safety requirements are needed for the performance of the Level III inspection beyond those listed in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Observe compressor operation and determine possible source of noise.
2. Carefully check compressor supports for loose, damaged or missing fasteners.
3. Check compressor electrical current draw.
4. Check for correct suction and discharge pressure.
5. Document readings and contact appropriate facility personnel if the readings indicate a suspected problem.

Special Tools and Equipment

The following is a list of special tools and equipment beyond those listed in the Standard Tool Section.

1. Ammeter
2. Refrigerant gauges

Recommended Inspection Frequency

Perform inspection when triggered by a Level I or other local factors such as problematic conditions.

References

1. NAVFAC MO-322, VoL. 2, Inspection of Shore Facilities, 1993

2. Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC, 1988

3. Modern Refrigeration and Air Conditioning, The Goodheart-Wilcox Company, Inc.,1968

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2*

COMPONENT: COMPRESSORS
CONTROL NUMBER: GS-III 32.03.02-2*

Application

This guide applies to sampling compressor oil to determine oil degradation, contamination and machine wear. Do not duplicate this effort if it is being performed under an existing base PM or recurring maintenance program.

Special Safety Requirements

No special safety requirements are needed for the performance of the Level III inspection beyond those listed in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Acquire a 50 ML sample of the chiller oil.
2. Perform a spectrochemical analysis of the oil sample to determine the oil degradation, oil contamination and machine wear.

Special Tools and Equipment

The following is a list of special tools and equipment beyond the requirements listed in the Standard Tool Section.

1. 50 ML container

Recommended Inspection Frequency

Annually

References

1. Jennings Laboratories 1118 Cypress Ave., Virginia Beach, VA
2. Operation and Maintenance of Centrifugal Units by Garth Denison CMS
3. The Locomotive, Hartford Steam Boiler Inspection and Insurance Co., Vol.66, Spring 1988

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3*

COMPONENT: COMPRESSORS
CONTROL NUMBER: GS-III 32.03.02-3*

Application

This guide applies to the partial disassembly of the compressor for inspection. Do not duplicate this effort if it is being performed under an existing base PM or recurring maintenance program. This inspection should be coordinated with Guide Sheet GS-III 32.03.02-4.

Special Safety Requirements

The following is a list of special safety requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Shut down chiller, tag and lock out disconnect.
2. Isolate compressor mechanically by pumping down system and securing valves on associated components.
3. Remove cylinder heads for examination of suction and discharge valves, valve springs and upper cylinder areas.
4. Remove crankcase cover plate and inspect the crankcase for metal particles which would indicate bearing wear.
5. Re-assemble the compressor.
6. Document any problems and contact appropriate facility personnel for further instructions.
7. Notify appropriate facility personnel for permission to place unit back in service if defects found are not critical to continued function.
8. Restore valving to normal position.
9. Remove tags, lockout on disconnect and restore unit to service.

Special Tools and Equipment

The following is a list of special tools and equipment, beyond the requirements listed in the Standard Tool Section.

1. Alignment Tools
2. Vibration Tester
3. Refrigerant Gauges

Recommended Inspection Frequency

Every 2 years or 10,000 hours of operation

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3* (Continued)

COMPONENT: COMPRESSORS
CONTROL NUMBER: GS-III 32.03.02-3*

References

1. NAVFAC MO-322, Vol.2, Inspection of Shore Facilities, 1993
2. Means Facilities Maintenance Standards, Roger W. Liska, P.E., AIC, 1988
3. CARRIER CORP, Catalogs 19.011, Forms 19EB-3SSM
4. TRANE CGWC-10M-3, Installation, Operation, Maintenance, Reciprocating Chiller
5. The Locomotive, The Hartford Steam Boiler Inspection and Insurance Co., Vol.66, Spring 1988

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 4*

COMPONENT: COMPRESSORS
CONTROL NUMBER: GS-III 32.03.02-4*

Application

This guide applies to the disassembly of the compressor for inspection of the connecting rod and piston assemblies. Do not duplicate this effort if it is being performed under an existing base PM or recurring maintenance program. This inspection should be coordinated with Guide Sheet GS-III 32.03.02-3.

Special Safety Requirements

The following is a list of special safety requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Shut down chiller, tag and lock out disconnect.
2. Isolate compressor mechanically by pumping down system and securing valves on associated components.
3. Remove connecting rod and piston assemblies to:
   a. Check piston rings for wear.
   b. Check connecting rod bearing surfaces for wear.
   c. Check connecting rod yokes, caps and bolts with dye penetrant.
   d. Check crankpin diameter for wear.
   e. Check oil pump for wear.
4. Re-assemble the compressor.
5. Document any problems and contact appropriate facility personnel for further instructions.
6. Notify appropriate facility personnel for permission to place unit back in service if defects found are not critical to continued function.
7. Restore valving to normal position.
8. Remove tags, lockout on disconnect and restore unit to service.

Special Tools and Equipment

The following is a list of special tools and equipment, beyond the requirements listed in the Standard Tool Section.

1. Alignment Tools
2. Vibration Tester
3. Dye Penetrant
4. Refrigerant Gauges

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 4* (Continued)

COMPONENT: COMPRESSORS
CONTROL NUMBER: GS-III 32.03.02-4*

Recommended Inspection Frequency

Every 4 years or 20,000 hours of operation

References

1. NAVFAC MO-322, Vol.2, Inspection of Shore Facilities, 1993
2. Means Facilities Maintenance Standards, Roger W. Liska, P.E., AIC, 1988
3. CARRIER CORP, Catalogs 19.011, Forms 19EB-3SSM
4. TRANE CGWC-10M-3, Installation, Operation, Maintenance, Reciprocating Chiller
5. The Locomotive, The Hartford Steam Boiler Inspection and Insurance Co., Spring 1988, Vol. 66, No.1

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 5*

COMPONENT: COMPRESSORS
CONTROL NUMBER: GS-III 32.03.02-5*

Application

This guide applies to checking the windings of electric motors for open circuits, grounds or deteriorated insulation. Do not duplicate this effort if it is being performed under an existing base PM or recurring maintenance program.

Special Safety Requirements

The following is a list of special requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.
2. Do not use this type of instrument in an explosive atmosphere.

Inspection Actions

1. Check line voltage and ampere load for proper balance.
2. Shut down motor, tag and lockout disconnect.
3. Remove the three phase leads (load conductors) at the motor terminals or at the starter. If leads are removed at the motor, tape conductor ends. Mark leads.
4. Perform grounding and dielectric resistance test on motor windings. Valves below 50 Megohms at an ambient temperature of 85 degrees F or less may indicate the presence of moisture in the winding insulation.
5. Document readings and contact appropriate facility personnel if the readings indicate a suspected problem.
6. Notify appropriate personnel for permission to place unit back in service if defect is not critical to continued function.
7. Make sure that leads are connected and covers have been installed; remove tags, lockout on disconnect and restore unit to service.

Special Tools and Equipment

The following is a list of special tools and equipment beyond those listed in the Standard Tool Section.

1. Megohmmeter

Recommended Inspection Frequency

Every 2 years

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 5* (Continued)

COMPONENT: COMPRESSORS
CONTROL NUMBER: GS-III 32.03.02-5*

References

1. The Locomotive, Vol. 69, Spring 1994, The Hartford Steam Boiler Inspection and Insurance Co., Inc.

2. Institute of Electrical and Electronic Engineers (IEEE), Specifications 112 (1984), 113 (1985) and 115 (1983)

3. National Electrical Manufactures' Association (NEMA) Book, MG 1-987, Part 12 (1987)

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 6*

COMPONENT: CONDENSERS - WATER COOLED
CONTROL NUMBER: GS-III 32.03.04-6*

Application

This guide applies to the checking of the tubes in the condenser for refrigerant leaks. Do not duplicate this effort if it is being performed under an existing base PM or recurring maintenance program.

Special Safety Requirements

The following is a list of special safety requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Shut down chiller, tag and lock out disconnect.
2. Isolate unit mechanically by pumping down system and securing valves on associated components.
3. Open end covers and inspect condition of tubes, check for refrigerant leaks using a dye penetrant on suspicious areas.
4. Replace end covers.
5. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.
6. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.
7. Restore valving to normal position.
8. Remove tags, lockout on disconnect and restore unit to service.

Special Tools and Equipment

The following is a list of special tools and equipment beyond the requirements listed in the Standard Tool Section.

1. Dye Penetrant
2. Refrigerant Gauges

Recommended Inspection Frequency

Annually

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 6* (Continued)

COMPONENT: CONDENSERS - WATER COOLED
CONTROL NUMBER: GS-III 32.03.04-6*

References

1. NAVFAC MO-322, Vol.2, Inspection of Shore Facilities, 1993
2. Means Facilities Maintenance Standards, Roger W. Liska, P.E., AIC, 1988
3. TRANE CGWC-10M-3, Installation, Operation, Maintenance, Reciprocating Chiller

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 7*

COMPONENT: CONDENSERS - WATER COOLED
CONTROL NUMBER: GS-III 32.03.04-7*

Application

This guide applies to the checking of the tubes in the condenser to detect deterioration which could lead to tube failure. Do not duplicate this effort if it is being performed under an existing base PM or recurring maintenance program.

Special Safety Requirements

The following is a list of special safety requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Shut down condenser, tag and lock out disconnect.
2. Drain condenser water sides.
3. Open end covers, perform eddy current tests in tubes and chart tube conditions..
4. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.
5. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.
6. Ensure all covers have been installed; remove tags, disconnect and restore unit to service.

Special Tools and Equipment

The following is a list of special tools and equipment beyond the requirements listed in the Standard Tool Section.

1. Multi-frequency signal generator
2. Cathode ray tube
3. Oscilloscope
4. Strip chart recorder
5. Eddy current probe

Recommended Inspection Frequency

Every 3 years

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 7* (Continued)

COMPONENT: CONDENSERS - WATER COOLED
CONTROL NUMBER: GS-III 32.03.04-7*

References

1. NAVFAC MO-322, Vol.2, Inspection of Shore Facilities, 1993

2. Means Facilities Maintenance Standards, Roger W. Liska, P.E., AIC, 1988

3. Modern Refrigeration and Air Conditioning, The Goodheart-Wilcox Company Inc.,1968

4. The Locomotive, The Hartford Steam Boiler Inspection and Insurance Co., Spring 1988, Vol.66

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 8*

COMPONENT: EVAPORATORS
CONTROL NUMBER: GS-III 32.03.05-8*

Application

This guide applies to the checking of the tubes in the evaporator for refrigerant leaks. Do not duplicate this effort if it is being performed under an existing base PM or recurring maintenance program.

Special Safety Requirements

The following is a list of special safety requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Shut down chiller, tag and lock out disconnect.
2. Isolate unit mechanically by pumping down system and securing valves on associated components.
3. Open end covers and inspect condition of tubes, check for refrigerant leaks using a dye penetrant on suspicious areas.
4. Replace end covers.
5. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.
6. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.
7. Restore valving to normal position.
8. Remove tags, lockout on disconnect and restore unit to service.

Special Tools and Equipment

The following is a list of special tools and equipment beyond the requirements listed in the Standard Tool Section.

1. Dye Penetrant
2. Refrigerant Gauges

Recommended Inspection Frequency

Annually

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 8* (Continued)

COMPONENT: EVAPORATORS
CONTROL NUMBER: GS-III 32.03.05-8*

References

1. NAVFAC MO-322, Vol.2, Inspection of Shore Facilities, 1993
2. Means Facilities Maintenance Standards, Roger W. Liska, P.E., AIC, 1988
3. TRANE CGWC-10M-3, Installation, Operation, Maintenance, Reciprocating Chiller

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 9*

COMPONENT: EVAPORATORS
CONTROL NUMBER: GS-III 32.03.05-9*

Application

This guide applies to checking tubes in the evaporator to detect deterioration which could lead to tube failure. Do not duplicate this effort if it is being performed under an existing base PM or recurring maintenance program.

Special Safety Requirements

The following is a list of special safety requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Shut down condenser, tag and lock out disconnect.
2. Drain condenser water sides.
3. Open end covers, perform eddy current tests in tubes and chart tube conditions.
4. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.
5. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.
6. Ensure all covers have been installed; remove tags, disconnect and restore unit to service.

Special Tools and Equipment

The following is a list of special tools and equipment beyond the requirements listed in the Standard Tool Section.

1. Multi-frequency signal generator
2. Cathode ray tube
3. Oscilloscope
4. Strip chart recorder
5. Eddy current probe

Recommended Inspection Frequency

Every 3 years

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 9* (Continued)

COMPONENT: EVAPORATORS
CONTROL NUMBER: GS-III 32.03.05-9*

References

1. NAVFAC MO-322, Vol.2, Inspection of Shore Facilities, 1993

2. Means Facilities Maintenance Standards, Roger W. Liska, P.E., AIC, 1988

3. Modern Refrigeration and Air Conditioning, The Goodheart-Wilcox Company Inc.,1968

4. The Locomotive, The Hartford Steam Boiler Inspection and Insurance Co., Spring 1988, Vol.66

32.04 CHILLERS - SCREW

DESCRIPTION

Chillers - Screw is a subsystem of the Central Cooling Plant. A screw chiller compresses gaseous refrigerant using helical rotors and produces cooling via water, through a shell and tube evaporator.

SPECIAL TOOL AND EQUIPMENT REQUIREMENTS

The following list of special tools and equipment, beyond the requirements listed in the Standard Tool Section, are required to perform the inspection of Chillers - Screw Systems.

1. Electronic Leak Detector

SPECIAL SAFETY REQUIREMENTS

No special safety requirements are needed for the inspection of the Chillers - Screw Systems, beyond the requirements listed in the Master Safety Plan and System Safety Section.

COMPONENT LIST

- 32.04.01 CHILLERS
- 32.04.02 PIPING, FITTINGS AND VALVES
- 32.04.03 CONTROLS AND INSTRUMENTATION

RELATED SUBSYSTEMS

Due to the related nature of the elements requiring inspection, the following sub-systems should be reviewed for concurrent inspection activities.

32.05 CHILLED WATER DISTRIBUTION SYSTEM
32.06 CONDENSER WATER DISTRIBUTION SYSTEM

32.04 CHILLERS - SCREW

STANDARD INSPECTION PROCEDURE

This subsystem requires both Level I and Level II inspection as part of the basic inspection process. Additional Level II inspections may be indicated or "triggered" by the Level I inspection observation and should be accomplished by the inspector at that time.

For electric motors in general use, Level I, II & III inspection methods will apply in accordance with the following horsepower ranges:

a. Use Level I inspection method if HP is less than 15.
b. Use Level II inspection method if HP is 15 to 60.
c. Use Level III inspection method if HP is greater than 60.

The Facility Manager will specify the level of inspection required for specialized motor applications.

Associated defects and observations, for each major component, are listed in the inspectors' Data Collection Devices.

COMPONENTS

◆ 32.04.01 CHILLERS

The chiller consists of a screw compressor, compressor motor, water cooled condenser, evaporator and lubrication system.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Excessive noise and vibration at the compressor.**			
Observation:			
a. Rattling noise.	EA		1
*** {Severity M}			
b. Grinding noise indicating metal to metal contact.	EA		1
*** {Severity H}			
*** Excessive noise and vibration at the motor.**			
Observation:			
a. Rattling noise.	EA	1	2
*** {Severity M}			
b. Grinding noise indicating metal to metal contact.	EA	1	2
*** {Severity H}			
c. Electrical arcing noise.	EA		3
*** {Severity H}			

32.04 CHILLERS - SCREW

COMPONENTS (Continued)

◆ **32.04.01 CHILLERS (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Leakage.**			
Observation:			
a. Evidence of water leakage at condenser.	EA		
*** {Severity M}			
b. Evidence of water leakage at evaporator.	EA		
*** {Severity M}			
c. Evidence of refrigerant leakage at compressor.	EA	2	
*** {Severity H}			
*** Defective electrical connectors.**			
Observation:			
a. Loose conduit or connectors.	EA		
*** {Severity M}			
b. Exposed wires or missing cover plates.	EA		
*** {Severity H}			
*** Defective mounting hardware.**			
Observation:			
a. Loose base tie-down bolts.	EA		
*** {Severity M}			
b. Missing base tie-down bolts.	EA		
*** {Severity H}			
*** Defective insulation.**			
Observation:			
a. Loose insulation.	SF		
*** {Severity L}			
b. Missing or damaged insulation.	SF		
*** {Severity H}			

32.04 CHILLERS - SCREW

COMPONENTS (Continued)

◆ **32.04.01 CHILLERS (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
* **Corrosion.**			
Observation:			
a. Surface corrosion no pitting evident.	SF		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	SF		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	SF		
*** {Severity H}			

32.04 CHILLERS - SCREW

COMPONENTS (Continued)

◆ 32.04.02 PIPING, FITTINGS AND VALVES

Piping, fittings and valves, that are part of the screw chiller, provide the refrigerant and lubricating oil circuits.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Defective fittings.**			
Observation:			
a. Bent or cracked fitting, not leaking. *** {Severity L}	EA		
b. Evidence of oil leaking. *** {Severity H}	EA		
c. Evidence of refrigerant leaking. *** {Severity H}	EA		3
*** Defective pipe.**			
Observation:			
a. Bent or cracked pipe, not leaking. *** {Severity L}	LF		
b. Evidence of oil leaking. *** {Severity H}	LF		
c. Evidence of refrigerant leaking. *** {Severity H}	LF		3
*** Defective valves.**			
Observation:			
a. Broken or missing valve handle. *** {Severity L}	EA		
b. Bent stem. *** {Severity M}	EA		
c. Cracked valve body. *** {Severity H}	EA		
d. Evidence of oil leaking. *** {Severity H}	EA		
e. Evidence of refrigerant leaking. *** {Severity H}	EA		3
*** Defective insulation.**			
Observation:			
a. Loose insulation. *** {Severity L}	LF		
b. Missing or damaged insulation. *** {Severity H}	LF		

32.04 CHILLERS - SCREW

COMPONENTS (Continued)

◆ 32.04.02 PIPING, FITTINGS AND VALVES (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corroded piping, fittings and valves**			
Observation:			
a. Surface corrosion no pitting evident.	LF		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	LF		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	LF		
*** {Severity H}			

32.04 CHILLERS - SCREW

COMPONENTS (Continued)

◆ 32.04.03 CONTROLS AND INSTRUMENTATION

Controls govern the operation of the chiller and instrumentation shows the status of the chiller components.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Physically damaged control/instrument panel.**			
Observation:			
a. Physically damaged panel.	EA		
*** {Severity M}			
b. Burned out pilot lamps.	EA		
*** {Severity F}			
c. Panel blocked, not accessible for inspection.	EA		
*** {Severity S}			
*** Defective control/instrument.**			
Observation:			
a. Broken/physically damaged.	EA		
*** {Severity M}			
b. Inoperable or missing.	EA		
*** {Severity H}			
*** Damaged mounting hardware or supports.**			
Observation:			
a. Loose mounting hardware or supports.	EA		
*** {Severity M}			
b. Broken or missing hardware or supports.	EA		
*** {Severity H}			

32.04 CHILLERS - SCREW

REFERENCES

1. NAVFAC MO-322, Vol.2, Inspection of Shore Facilities, 1993
2. Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC, 1988
3. TRANE Air Conditioning Clinic Booklet, Helical Rotary Water Chillers
4. TRANE RTHA-IOM-IA, Operation/Maintenance, Rotary Liquid Chillers
5. CARRIER 1992/1993, Products and Systems Master Catalog
6. 1992 ASHRAE Handbook: Heating, Ventilating and Air-Conditioning Systems and Equipment
7. Refrigeration and Air-Conditioning, Second Edition, Billy C. Langley, Reston Publishing Company, Inc., 1982
8. Electricity for Refrigeration, Heating and Air-Conditioning, Second Edition, Russell E. Smith, Breton Publishers, 1983

32.04 CHILLERS - SCREW

LEVEL II KEYS	GUIDE SHEET CONTROL NUMBER
1	GS-II 32.04.01-1
2	GS-II 32.04.01-2
3	GS-II 32.04.02-3

LEVEL III KEYS	GUIDE SHEET CONTROL NUMBER
1	GS-III 32.04.01-1
2	GS-III 32.04.01-2
3	GS-III 32.04.01-3
4*	GS-III 32.04.01-4*
5*	GS-III 32.04.01-5*
6*	GS-III 32.04.01-6*
7*	GS-III 32.04.01-7*
8*	GS-III 32.04.01-8*

* Indicates guide sheets which are not directly referenced by a Key. These are "triggered" by information beyond the inspection process such as time, age or repeated service calls.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 1

COMPONENT: CHILLERS
CONTROL NUMBER: GS-II 32.04.01-1

Application

This guide applies to the investigation of rattling and grinding (metal to metal) noise from the chiller motor.

For electric motors in general use, Level I, II & III inspection methods will apply in accordance with the following horsepower ranges:

1. Use Level I inspection method if HP is less than 15.
2. Use Level I & II inspection methods if HP is 15 to 60.
3. Use Level I, II and/or III inspection if HP is greater than 60.

The Facility Manager will specify the level of inspection required for specialized motor applications.

Special Safety Requirements

The following is a list of special safety requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Observe motor operation and determine possible source of noise.
2. Shut down motor, tag and lock out disconnect.
3. Check coupling for wear, damage or loose fasteners.
4. Visually check interior of motor housing for other physical damage, if an open motor.
5. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.
6. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.
7. Ensure all guards and covers have been installed; remove tags, lockout on disconnect and restore unit to service.

Recommended Inspection Frequency

Perform inspection when triggered by a Level I or other local factors such as problematic conditions.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 1 (Continued)

COMPONENT: CHILLERS
CONTROL NUMBER: GS-II 32.04.01-1

References

1. Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC, 1988

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 2

COMPONENT: CHILLERS
CONTROL NUMBER: GS-II 32.04.01-2

Application

This guide applies to the investigation of refrigerant leaking at the compressor.

Special Safety Requirements

No special safety requirements are needed for the performance of the Level II inspection beyond those listed in the Master Safety Section.

Inspection Actions

1. Check compressor for refrigerant leaks at gaskets, sight glass and shut-off valves.
2. Check compressor for cracks in the body.
3. Check for leaks at the compressor terminals.
4. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.

Recommended Inspection Frequency

Perform inspection when triggered by a Level I or other local factors such as problematic conditions.

References

1. NAVFAC MO-322, Vol.2, Inspection of Shore Facilities, 1993

2. Modern Refrigeration and Air Conditioning, The Goodheart-Wilcox Company Inc.,1968

3. TRANE RTHA-IOM-IA, Operation/Maintenance Rotary Liquid Chillers

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 3

COMPONENT: PIPING, FITTINGS AND VALVES
CONTROL NUMBER: GS-II 32.04.02-3

Application

This guide applies to the investigation of refrigerant leaking at piping, fittings and valves.

Special Safety Requirements

No special safety requirements are needed for the performance of the Level II inspection beyond those listed in the Master Safety Section.

Inspection Actions

1. Check piping, fittings and valves for refrigerant leaks.
2. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.

Recommended Inspection Frequency

Perform inspection when triggered by a Level I inspection or other local factors such as problematic conditions.

References

1. NAVFAC MO-322, Vol.2, Inspection of Shore Facilities, 1993

2. Modern Refrigeration and Air Conditioning, The Goodheart-Wilcox Company Inc.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1

COMPONENT: CHILLERS
CONTROL NUMBER: GS-III 32.04.01-1

Application

This guide applies to the investigation of rattling and grinding (metal to metal) noise from the screw compressor.

Special Safety Requirements

The following is a list of special safety requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Observe compressor operation and determine possible source of noise.
2. Perform vibration analysis on compressor bearings.
3. Shut down compressor, tag and lock out disconnect.
4. Isolate unit mechanically by pumping down system and securing valves on associated components.
5. Open and inspect compressor interior housing for cracks, fatigue, erosion, and corrosion, check suspicious areas with dye penetrant.
6. Check interior shafting for signs of fatigue.
7. Check compressor shafting for damage from packing/mechanical seal.
8. Check rotors for erosion/corrosion, physical damage, distortion.
9. Rotate (cycle) shafting and check for distortion in shaft.
10. Check clearances between rotors; compare with manufacturer's specifications.
11. Close compressor.
12. Rotate (cycle) compressor to check for binding.
13. Measure run-out play in bearings due to wear; compare with manufacturer's specifications.
14. Ensure that all seals and covers have been reinstalled.
15. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.
16. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.
17. Restore valving to normal position.
18. Remove tags, lockout on disconnect and restore unit to service.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1 (Continued)

COMPONENT: CHILLERS
CONTROL NUMBER: GS-III 32.04.01-1

Special Tools and Equipment

The following is a list of special tools and equipment beyond those listed in the Standard Tool Section.

1. Alignment Tools
2. Vibration Tester
3. Dye Penetrant
4. Refrigerant Gauges

Recommended Inspection Frequency

Perform inspection when triggered by Level I and Level II inspections or other local factors such as problematic conditions.

References

1. NAVFAC MO-322, Vol.2, Inspection of Shore Facilities, 1993
2. Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC 1988
3. TRANE RTHA-IOM-IA, Operation/Maintenance Rotary Liquid Chillers

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2

COMPONENT: CHILLERS
CONTROL NUMBER: GS-III 32.04.01-2

Application

This guide applies to the investigation of rattling and grinding (metal to metal) noise from the chiller motor.

For electric motors in general use, Level I, II & III inspection methods will apply in accordance with the following horsepower ranges:

1. Use Level I inspection method if HP is less than 15.
2. Use Level I & II inspection methods if HP is 15 to 60.
3. Use Level I, II and/or III inspection if HP is greater than 60.

The Facility Manager will specify the level of inspection required for specialized motor applications.

Special Safety Requirements

The following is a list of special requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Observe motor operation and determine possible source of noise.
2. Perform vibration analysis on motor bearings.
3. Shut down motor, tag and lock out disconnect.
4. Isolate unit mechanically by pumping down system and securing valves on associated components.
5. Rotate (cycle) motor to check for binding.
6. Measure run-out play in bearings due to wear; compare with manufacturer's specifications.
7. Open and inspect motor interior housing for cracks, fatigue, erosion and corrosion, check suspicious areas with dye penetrant.
8. Check interior shafting for signs of fatigue or wear.
9. Rotate (cycle) shafting and check for distortion.
10. Document the problem and contact appropriate facility personnel for further instructions and reassemble motor, if directed.
11. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.
12. Ensure all guards and covers have been installed; remove tags, lockout on disconnect and restore unit to service.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2 (Continued)

COMPONENT: CHILLERS
CONTROL NUMBER: GS-III 32.04.01-2

Special Tools and Equipment

The following is a list of special tools and equipment beyond those listed in the Standard Tool Section.

1. Alignment Tools
2. Vibration Tester
3. Dye Penetrant

Recommended Inspection Frequency

Perform inspection when triggered by Level I and Level II inspections or other local factors such as problematic conditions.

References

1. Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC, 1988

2. Electric Motor & Contracting Co. Inc., Chesapeake, VA

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3

COMPONENT: CHILLERS
CONTROL NUMBER: GS-III 32.04.01-3

Application

This guide applies to the investigation of electrical arcing noise from the chiller motor.

For electric motors in general use, Level I, II & III inspection methods will apply in accordance with the following horsepower ranges:

1. Use Level I inspection method if HP is less than 15.
2. Use Level I & II inspection methods if HP is 15 to 60.
3. Use Level I, II and/or III inspection if HP is greater than 60.

The Facility Manager will specify the level of inspection required for specialized motor applications.

Special Safety Requirements

The following is a list of special requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Observe motor operation and determine possible source of noise.
2. Check voltage at motor and current draw. Compare to motor ratings and the requirements of the associated equipment.
3. Perform vibration analysis on the motor.
4. Rotate motor shaft and check for binding, rubbing.
5. Measure run-out play in bearings due to wear; compare with manufacturer's specification.
6. Check alignment.
7. Shut down motor, tag and lock out disconnect.
8. Isolate unit mechanically by pumping down system and securing valves on associated components.
9. Open motor and inspect interior housing for stress cracks, corrosion, other physical damage, check suspicious areas with dye penetrant.
10. Check stator windings for dirt, moisture, physical damage, signs of overheating, loose fasteners.
11. Check rotor windings for dirt, moisture, physical damage, signs of overheating, loose fasteners.
12. Check commutator/slip rings for loose parts, physical damage, wear.
13. Check brushes for wear, proper tension.
14. Check bearings for lube leakage into motor.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3 (Continued)

COMPONENT: CHILLERS
CONTROL NUMBER: GS-III 32.04.01-3

Inspection Actions (Continued)

15. Check motor shafting for wear.
16. Document the problem and contact appropriate facility personnel for further instructions and reassemble motor, if directed.
17. Notify appropriate personnel for permission to place unit back in service if defect is not critical to continued function.
18. Ensure all guards and covers have been installed; evacuate air from system and recharge, remove tags, lockout on disconnect and restore unit to service.

Special Tools and Equipment

The following is a list of special tools and equipment beyond those listed in the Standard Tool Section.

1. Alignment Tools
2. Vibration Tester
3. Infrared Temperature Tester
4. Ammeter
5. Voltmeter
6. Dye Penetrant
7. Refrigerant gauges

Recommended Inspection Frequency

Perform inspection when triggered by Level I and Level II inspections or other local factors such as problematic conditions.

References

1. Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC, 1988

2. Electric Motor & Contracting Co. Inc., Chesapeake, VA

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 4*

COMPONENT: CHILLERS
CONTROL NUMBER: GS-III 32.04.01-4*

Application

This guide applies to checking the windings of electric motors for open circuits, grounds or deteriorated insulation. Do not duplicate this effort if it is being performed under an existing base PM or recurring maintenance program.

Special Safety Requirements

The following is a list of special requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.
2. Large electrical equipment such as motors above 500 HP usually have sufficient capacitance to store a dangerous amount of energy from the test current. Make sure this capacitance is discharged after each test and before handling the test leads.
3. Do not use the megohmmeter in an explosive atmosphere.

Inspection Actions

1. Check line voltage and ampere load for proper balance.
2. Shut down motor, tag and lockout disconnect.
3. Remove the three phase leads (load conductors) at the motor terminals or at the starter. If leads are removed at the motor, tape conductor ends. Mark leads.
4. Perform grounding and dielectric resistance test on motor windings. Values below 50 Megohms at an ambient temperature of 85 degrees F or less may indicate the presence of moisture in the winding insulation.
5. Document readings and contact appropriate facility personnel if the readings indicate a suspected problem.
6. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.
7. Make sure that leads are connected and covers have been installed; remove tags, lockout on disconnect and restore unit to service.

Special Tools and Equipment

The following is a list of special tools and equipment beyond those listed in the Standard Tool Section.

1. Megohmmeter

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 4* (Continued)

COMPONENT: CHILLERS
CONTROL NUMBER: GS-III 32.04.01-4*

Recommended Inspection Frequency

Annually

References

1. The Locomotive, Vol. 69, Spring 1994, The Hartford Steam Boiler Inspection and Insurance Co., Inc.

2. Institute of Electrical and Electronic Engineers (IEEE), Specifications 112 (1984), 113 (1985) and 115 (1983)

3. National Electrical Manufactures' Association (NEMA) Book, MG 1-987, Part 12 (1987)

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 5*

COMPONENT: CHILLERS
CONTROL NUMBER: GS-III 32.04.01-5*

Application

This guide applies to sampling chiller oil to determine oil degradation, contamination and machine wear. Do not duplicate this effort if it is being performed under an existing base PM or recurring maintenance program.

Special Safety Requirements

No special safety requirements are needed for the performance of the Level II inspection beyond those listed in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Acquire a 50 ML sample of the chiller oil.
2. Perform a spectrochemical analysis of the oil sample to determine the oil degradation, oil contamination and machine wear.

Special Tools and Equipment

The following is a list of special tools and equipment beyond those listed in the Standard Tool Section.

1. 50 ML container

Recommended Inspection Frequency

Annually

References

1. Jennings Laboratories 1118 Cypress Ave., Virginia Beach, VA

2. The Locomotive, Hartford Steam Boiler Inspection and Insurance Co., Vol. 66, Spring 1988

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 6*

COMPONENT: CHILLERS
CONTROL NUMBER: GS-III 32.04.01-6*

Application

This guide applies to the checking of the tubes in the condenser and heat recovery units for refrigerant leaks. Do not duplicate this effort if it is being performed under an existing base PM or recurring maintenance program.

Special Safety Requirements

The following is a list of special safety requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Shut down chiller, tag and lock out disconnect.
2. Isolate unit mechanically by pumping down system and securing valves on associated components.
3. Open end covers and inspect condition of tubes, check for refrigerant leaks using a dye penetrant on suspicious areas.
4. Replace end covers.
5. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.
6. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.
7. Restore valving to normal position.
8. Remove tags, lockout on disconnect and restore unit to service.

Special Tools and Equipment

The following is a list of special tools and equipment beyond those listed in the Standard Tool Section.

1. Dye Penetrant
2. Refrigerant Gauges

Recommended Inspection Frequency

Annually

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 6* (Continued)

COMPONENT: CHILLERS
CONTROL NUMBER: GS-III 32.04.01-6*

References

1. NAVFAC MO-322, Vol.2, Inspection of Shore Facilities, 1993
2. Means Facilities Maintenance Standards, Roger W. Liska, P.E., AIC, 1988
3. TRANE RTHA-IOM-IA, Operation/Maintenance Rotary Liquid Chillers

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 7*

COMPONENT: CHILLERS
CONTROL NUMBER: GS-III 32.04.01-7*

Application

This guide applies to the disassembly of the compressor for inspection. Do not duplicate this effort if it is being performed under an existing base PM or recurring maintenance program.

Special Safety Requirements

The following is a list of special safety requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Shut down chiller, tag and lock out disconnect.
2. Isolate compressor mechanically by pumping down system and securing valves on associated components.
3. Perform nondestructive tests of the internal parts of the compressor, according to the manufacturer's recommendations.
4. Re-assemble the compressor.
5. Document any problems and contact appropriate facility personnel for further instructions.
6. Notify appropriate facility personnel for permission to place unit back in service if defects found are not critical to continued function.
7. Restore valving to normal position.
8. Remove tags, lockout on disconnect and restore unit to service.

Special Tools and Equipment

The following is a list of special tools and equipment beyond those listed in the Standard Tool Section.

1. Alignment Tools
2. Vibration Tester
3. Dye Penetrant
4. Refrigerant Gauges

Recommended Inspection Frequency

Every 4 years or 20,000 hours of operation

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 7* (Continued)

COMPONENT: CHILLERS
CONTROL NUMBER: GS-III 32.04.01-7*

References

1. NAVFAC MO-322, Vol.2, Inspection of Shore Facilities, 1993
2. Means Facilities Maintenance Standards, Roger W. Liska, P.E., AIC, 1988
3. CARRIER CORP, Catalogs 19.011, Forms 19EB-3SSM

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 8*

COMPONENT: CHILLERS
CONTROL NUMBER: GS-III 32.04.01-8*

Application

This guide applies to checking tubes in the condenser and evaporator to detect deterioration which could lead to tube failure. Do not duplicate this effort if it is being performed under an existing base PM or recurring maintenance program.

Special Safety Requirements

The following is a list of special safety requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Shut down condenser, tag and lock out disconnect.
2. Drain condenser and evaporator water sides.
3. Open end covers, perform eddy current tests in tubes and chart tube conditions.
4. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.
5. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.
6. Ensure all covers have been installed; remove tags, disconnect and restore unit to service.

Special Tools and Equipment

The following is a list of special tools and equipment beyond the requirements listed in the Standard Tool Section.

1. Multi-frequency signal generator
2. Cathode ray tube
3. Oscilloscope
4. Strip chart recorder
5. Eddy current probe

Recommended Inspection Frequency

Every 3 years.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 8* (Continued)

COMPONENT: CHILLERS
CONTROL NUMBER: GS-III 32.04.01-8*

References

1. NAVFAC MO-322, Vol.2, Inspection of Shore Facilities, 1993

2. Means Facilities Maintenance Standards, Roger W. Liska, P.E., AIC, 1988

3. Modern Refrigeration and Air Conditioning, The Goodheart-Wilcox Company Inc.,1968

4. The Locomotive, The Hartford Steam Boiler Inspection and Insurance Co., Spring 1988, Vol.66

32.05 CHILLED WATER DISTRIBUTION SYSTEMS

DESCRIPTION

Chilled Water Distribution Systems is a subsystem of the Central Cooling Plant. The typical chilled water distribution system circulates chilled water from generating equipment to the exterior chilled water distribution system.

SPECIAL TOOL AND EQUIPMENT REQUIREMENTS

No special tools are needed for the inspection of Chilled Water Distribution Systems, beyond the requirements listed in the Standard Tools Section.

SPECIAL SAFETY REQUIREMENTS

No special safety requirements are needed for the inspection of Chilled Water Distribution Systems, beyond the requirements listed in the Master Safety Plan and System Safety Section.

COMPONENT LIST

- 32.05.01 PUMP BASES AND COUPLINGS
- 32.05.02 PUMPS
- 32.05.03 MOTORS
- 32.05.04 CONTROLS
- 32.05.05 EXPANSION TANKS
- 32.05.06 PIPING, FITTINGS AND VALVES

RELATED SUBSYSTEMS

Due to the related nature of the elements requiring inspection, the following should be reviewed for concurrent inspection activities.

23.05	CHILLED WATER DISTRIBUTION SYSTEMS
32.01	CHILLERS - ABSORPTION
32.02	CHILLERS - CENTRIFUGAL
32.03	CHILLERS - RECIPROCATING
32.04	CHILLERS - SCREW

32.05 CHILLED WATER DISTRIBUTION SYSTEMS

STANDARD INSPECTION PROCEDURE

This subsystem requires both Level I and Level II inspection as part of the basic inspection process. Additional Level II inspections may be indicated or "triggered" by the Level I inspection observation and should be accomplished by the inspector at that time.

For pumps in general use, Level I, II & III inspection methods will apply in accordance with the following gallon-per-minute ranges:

a. Use Level I inspection method if GPM is less than 40.
b. Use Level I, II and/or III inspection methods if GPM is 40 or greater.

For electric motors in general use, Level I, II & III inspection methods will apply in accordance with the following horsepower ranges:

a. Use Level I inspection method if HP is less than 15.
b. Use Level II inspection method if HP is 15 to 60.
c. Use Level III inspection method if HP is greater than 60.

The Facility Manager will specify the level of inspection required for specialized pump and motors applications.

Associated defects and observations, for each major component, are listed in the inspectors' Data Collection Devices.

COMPONENTS

◆ 32.05.01 PUMP BASES AND COUPLINGS

The pump base is the mounting platform for the pump and motor. The coupling is the mechanical connection between the pump and motor.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Defective pump or motor mounting bolts.**			
Observation:			
a. Loose pump or motor mounting bolts.	EA		
*** {Severity M}			
b. Broken or missing pump or motor mounting bolts.	EA		
*** {Severity H}			

32.05 CHILLED WATER DISTRIBUTION SYSTEMS

COMPONENTS (Continued)

◆ **32.05.01 PUMP BASES AND COUPLINGS (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Defective mounting hardware.**			
Observation:			
a. Loose base tie-down bolts.	EA		
*** {Severity M}			
b. Missing base tie-down bolts or isolators.	EA		
*** {Severity H}			
*** Defective coupling guard.**			
Observation:			
a. Loose coupling guard.	EA		
*** {Severity L}			
b. Missing or damaged coupling guard.	EA		
*** {Severity H}			
*** Defective coupling.**			
Observation:			
a. Loose set screws.	EA		
*** {Severity M}			
b. Missing set screws.		EA	
*** {Severity H}			
*** Corrosion (base).**			
Observation:			
a. Surface corrosion no pitting evident.	EA		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	EA		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	EA		
*** {Severity H}			
*** Abandoned pump assembly (disconnected).**			
Observation:			
a. Inactive pump assembly abandoned, requiring proper disposal.	EA		
*** {Severity L}			

32.05 CHILLED WATER DISTRIBUTION SYSTEMS

COMPONENTS (Continued)

◆ 32.05.02 PUMPS

Pumps provide for chilled water circulation throughout the distribution system.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Damaged pump.**			
Observation:			
a. Cracked pump housing.	EA		
*** {Severity H}			
b. Broken pump base.	EA		
*** {Severity H}			
*** Leakage.**			
Observation:			
a. Leaking at pump fittings or seals.	EA		
*** {Severity M}			
b. Cracked or damaged pump housing.	EA		
*** {Severity H}			
*** Excessive noise and vibration.**			
Observation:			
a. Rattling noise.	EA	1	1
*** {Severity M}			
b. Grinding noise, indicating metal to metal contact.	EA	1	1
*** {Severity H}			
*** Defective insulation.**			
Observation:			
a. Loose insulation.	SF		
*** {Severity L}			
b. Missing or damaged insulation.	SF		
*** {Severity H}			
*** Corrosion.**			
Observation:			
a. Surface corrosion no pitting evident.	EA		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	EA		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	EA		
*** {Severity H}			

32.05 CHILLED WATER DISTRIBUTION SYSTEMS

COMPONENTS (Continued)

◆ 32.05.03 MOTORS

Electric motors are used to drive the circulating pumps. In-line circulating pumps are typically driven via spring-coupled motors, pedestal-mounted pumps are typically driven via rigid or flex-coupled motors.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Damaged motor.**			
Observation:			
a. Cracked/damaged housing or end bells.	EA		
*** {Severity H}			
b. Broken motor base.	EA		
*** {Severity H}			
*** Excessive noise and vibration.**			
Observation:			
a. Rattling noise.	EA	2	2
*** {Severity M}			
b. Grinding noise, indicating metal to metal contact.	EA	2	2
*** {Severity H}			
c. Electrical arcing noise.	EA		3
*** {Severity H}			
*** Defective electrical connectors.**			
Observation:			
a. Loose conduit or connectors.	EA		
*** {Severity M}			
b. Exposed wires or missing cover plates.	EA		
*** {Severity H}			

32.05 CHILLED WATER DISTRIBUTION SYSTEMS

COMPONENTS (Continued)

◆ 32.05.04 CONTROLS

Controls govern the operation of the motor driven pump equipment. The controls normally consist of disconnects, starters and controllers.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Excessive noise.**			
Observation:			
a. Electrical arcing noise.	EA		5
*** {Severity H}			
*** Physically damaged control panel.**			
Observation:			
a. Control panel blocked, not accessible for inspection.	EA		
*** {Severity S}			
b. Burned out pilot lamps.	EA		
*** {Severity F}			
c. Physically damaged control panel enclosure.	EA		
*** {Severity M}			
*** Corrosion.**			
Observation:			
a. Surface corrosion no pitting evident.	EA		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	EA		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	EA		
*** {Severity H}			

32.05 CHILLED WATER DISTRIBUTION SYSTEMS

COMPONENTS (Continued)

◆ 32.05.05 EXPANSION TANKS

Expansion Tanks are closed steel containers that are used to compensate for the change in water volume caused by the system temperature variation. Expansion Tanks are normally installed near the ceiling.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Leakage.**			
Observation:			
a. Water dripping from tank fitting.	EA		
*** {Severity L}			
b. Leakage at tank seams.	EA		
*** {Severity H}			
*** Defective water column.**			
Observation:			
a. Residual buildup inside sight glass, poor visibility.	EA		
*** {Severity L}			
b. Cracked or broken sight glass.	EA		
*** {Severity H}			
*** Physical tank damage.**			
Observation:			
a. Abrasions.	SF		
*** {Severity L}			
b. Impact damage, dents.	SF		
*** {Severity M}			
*** Defective insulation.**			
Observation:			
a. Loose insulation.	SF		
*** {Severity L}			
b. Missing or damaged insulation.	SF		
*** {Severity H}			

32.05 CHILLED WATER DISTRIBUTION SYSTEMS

COMPONENTS (Continued)

◆ 32.05.05 EXPANSION TANKS (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion.**			
Observation:			
a. Surface corrosion no pitting evident.	SF		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	SF		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	SF		
*** {Severity H}			

32.05 CHILLED WATER DISTRIBUTION SYSTEMS

COMPONENTS (Continued)

◆ 32.05.06 PIPING, FITTINGS AND VALVES

Piping and fittings provide the distribution network for the chilled water system. Valves are installed to control the water supply, isolate system parts and provide a means for drainage.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Defective fittings.**			
Observation:			
a. Bent or cracked fitting, not leaking.	EA		
*** {Severity L}			
b. Water leaking.	EA		
*** {Severity H}			
*** Defective pipe.**			
Observation:			
a. Bent or cracked pipe, not leaking.	LF		
*** {Severity L}			
b. Water leaking.	LF		
*** {Severity H}			
*** Defective valves.**			
Observation:			
a. Broken or missing valve handle.	EA		
*** {Severity L}			
b. Bent stem.	EA		
*** {Severity M}			
c. Leaking valve packing glands/gaskets.	EA		
*** {Severity M}			
d. Cracked valve body.	EA		
*** {Severity H}			
*** Defective guides or anchors.**			
Observation:			
a. Loose guides or anchors.	EA		
*** {Severity L}			
b. Broken or missing guides or anchors.	EA		
*** {Severity H}			
*** Defective supports or hangers.**			
Observation:			
a. Loose supports or hangers.	EA		
*** {Severity L}			
b. Broken or missing supports or hangers.	EA		
*** {Severity H}			

32.05 CHILLED WATER DISTRIBUTION SYSTEMS

COMPONENTS (Continued)

◆ 32.05.06 PIPING, FITTINGS AND VALVES (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Defective insulation.**			
Observation:			
a. Loose insulation.	LF		
*** {Severity L}			
b. Damaged or missing insulation.	LF		
*** {Severity M}			
*** Corroded piping and fittings.**			
Observation:			
a. Surface corrosion no pitting evident.	LF		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	LF		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	LF		
*** {Severity H}			
*** Corroded valves.**			
Observation:			
a. Surface corrosion no pitting evident.	EA		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	EA		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	EA		
*** {Severity H}			
*** Corroded hangers or supports.**			
Observation:			
a. Surface corrosion no pitting evident.	EA		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	EA		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	EA		
*** {Severity H}			

32.05 CHILLED WATER DISTRIBUTION SYSTEMS

COMPONENTS (Continued)

◆ 32.05.06 PIPING, FITTINGS AND VALVES (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Defective pipe labeling.**			
Observation:			
a. Damaged/missing labels.	EA		
*** {Severity L}			

32.05 CHILLED WATER DISTRIBUTION SYSTEMS

REFERENCES

1. NAVFAC MO-322, Vol.2, Inspection of Shore Facilities, 1993

2. Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC 1988

32.05 CHILLED WATER DISTRIBUTION SYSTEMS

LEVEL II KEY	GUIDE SHEET CONTROL NUMBER
1	GS-II 32.05.02-1
2	GS-II 32.05.03-2

LEVEL III KEY	GUIDE SHEET CONTROL NUMBER
1	GS-III 32.05.02-1
2	GS-III 32.05.03-2
3	GS-III 32.05.03-3
4*	GS-III 32.05.03-4*
5	GS-III 32.05.04-5

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 1

COMPONENT: PUMPS
CONTROL NUMBER: GS-II 32.05.02-1

Application

This guide applies to the investigation of rattling and grinding (metal to metal) noise from the pump.

For pumps in general use, Level I, II & III inspection methods will apply in accordance with the following gallon-per-minute ranges:

a. Use Level I inspection method if GPM is less than 40.
b. Use Level I, II and/or III inspection methods if GPM is 40 or greater.

The Facility Manager will specify the level of inspection required for specialized pump applications.

Special Safety Requirements

The following is a list of special safety requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Observe pump operation and determine possible source of noise.
2. Shut down pump, tag and lock out disconnect.
3. Check coupling for wear, damage or loose fasteners..
4. Examine drives for alignment.
5. Turn pump by hand and determine what is causing the noise.
6. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.
7. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.
8. Ensure all guards and covers have been installed; remove tags, lockout on disconnect and restore unit to service.

Recommended Inspection Frequency

Perform inspection when triggered by a Level I or other local factors such as problematic conditions.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 1 (Continued)

COMPONENT: PUMPS
CONTROL NUMBER: GS-II 32.05.02-1

References

1. Means Facilities Maintenance Standard, Roger W. Liska, PE, AIC, 1988

2. NAVFAC MO-209, Maintenance of Steam, Hot Water and Compressed Air Distribution Systems, 1989

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 2

COMPONENT: MOTORS
CONTROL NUMBER: GS-II 32.05.03-2

Application

This guide applies to the investigation of rattling and grinding (metal to metal) noise from the motor.

For electric motors in general use, Level I, II & III inspection methods will apply in accordance with the following horsepower ranges:

1. Use Level I inspection method if HP is less than 15.
2. Use Level I & II inspection methods if HP is 15 to 60.
3. Use Level I, II and/or III inspection if HP is greater than 60.

The Facility Manager will specify the level of inspection required for specialized motor applications.

Special Safety Requirements

The following is a list of special safety requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Observe motor operation and determine possible source of noise.
2. Shut down motor, tag and lock out disconnect.
3. Check coupling for wear, damage or loose fasteners.
4. Visually check interior of motor housing for other physical damage, if an open motor.
5. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.
6. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.
7. Ensure all guards and covers have been installed; remove tags, lockout on disconnect and restore unit to service.

Recommended Inspection Frequency

Perform inspection when triggered by a Level I or other local factors such as problematic conditions.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 2 (Continued)

COMPONENT: MOTORS
CONTROL NUMBER: GS-II 32.05.03-2

References

1. Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC, 1988.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1

COMPONENT: PUMPS
CONTROL NUMBER: GS-III 32.05.02-1

Application

This guide applies to the investigation of rattling and grinding (metal to metal) noise from the pump.

For pumps in general use, Level I, II & III inspection methods will apply in accordance with the following gallon-per-minute ranges:

a. Use Level I inspection method if GPM is less than 40.
b. Use Level I, II and/or III inspection methods if GPM is 40 or greater.

The Facility Manager will specify the level of inspection required for specialized pump applications.

Special Safety Requirements

The following is a list of special safety requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Observe pump operation and determine possible source of noise.
2. Perform vibration analysis on pump bearings.
3. Shut down pump, tag and lock out disconnect.
4. Isolate unit mechanically.
5. Rotate (cycle) pump to check for binding.
6. Measure run-out play in bearings due to wear; compare with manufacturer's specifications.
7. Check coupling for wear, damage, loose fasteners.
8. Check coupling for misalignment.
9. Open and inspect pump interior housing for cracks, fatigue, erosion, and corrosion, check suspicious areas.
10. Check interior shafting for signs of damage, fatigue or wear.
11. Check impellers for erosion/corrosion, physical damage, distortion.
12. Rotate (cycle) shafting and check for distortion in shaft.
13. Check clearances between impeller and wear rings; compare with manufacturer's specifications.
14. Document the problem and contact appropriate facility personnel for further instructions and reassemble pump, if directed.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1 (Continued)

COMPONENT: PUMPS
CONTROL NUMBER: GS-III 32.05.02-1

Inspection Actions (Continued)

15. Notify appropriate personnel for permission to place unit back in service if defect is not critical to continued function.
16. Ensure all guards and covers have been installed; remove tags, lockout on disconnect and restore unit to service.

Special Tools and Equipment

The following is a list of special tools and equipment, beyond those listed in the Standard Tool Section, required to perform the inspection of the pump.

1. Alignment Tools
2. Vibration Tester
3. Dye Penetrant

Recommended Inspection Frequency

Perform inspection when triggered by Level I and Level II inspections or other local factors such as problematic conditions.

References

1. Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC 1988.

2 Sydnor Hydrodynamics Inc., Portsmouth, VA

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2

COMPONENT: MOTORS
CONTROL NUMBER: GS-III 32.05.03-2

Application

This guide applies to the investigation of rattling and grinding (metal to metal) noise from the motor.
For electric motors in general use, Level I, II & III inspection methods will apply in accordance with the following horsepower ranges:

1. Use Level I inspection method if HP is less than 15.
2. Use Level I & II inspection methods if HP is 15 to 60.
3. Use Level I, II and/or III inspection if HP is 60 or greater.

The Facility Manager will specify the level of inspection required for specialized motor applications.

Special Safety Requirements

The following is a list of special requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Observe motor operation and determine possible source of noise.
2. Perform vibration analysis on motor bearings.
3. Shut down motor, tag and lock out disconnect.
4. Rotate (cycle) motor to check for binding.
5. Measure run-out play in bearings due to wear; compare with manufacturer's specifications.
6. Open and inspect motor interior housing for cracks, fatigue, erosion and corrosion, check suspicious areas with dye penetrant.
7. Check interior shafting for signs of fatigue or wear.
8. Rotate (cycle) shafting and check for distortion.
9. Document the problem and contact appropriate facility personnel for further instructions and reassemble motor, if directed.
10. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.
11. Ensure all guards and covers have been installed; remove tags, lockout on disconnect and restore unit to service.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2 (Continued)

COMPONENT: MOTORS
CONTROL NUMBER: GS-III 32.05.03-2

Special Tools and Equipment

The following is a list of special tools and equipment beyond those listed in the Standard Tool Section.

1. Alignment Tools
2. Vibration Tester
3. Dye Penetrant

Recommended Inspection Frequency

Perform inspection when triggered by Level I and Level II inspections or other local factors such as problematic conditions.

References

1. Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC, 1988

2. Electric Motor & Contracting Co. Inc., Chesapeake, VA

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3

COMPONENT: MOTORS
CONTROL NUMBER: GS-III 32.05.03-3

Application

This guide applies to the investigation of electrical arcing noise from the motor.

For electric motors in general use, Level I, II & III inspection methods will apply in accordance with the following horsepower ranges:

1. Use Level I inspection method if HP is less than 15.
2. Use Level I & II inspection methods if HP is 15 to 60.
3. Use Level I, II and/or III inspection if HP is 60 or greater.

The Facility Manager will specify the level of inspection required for specialized motor applications.

Special Safety Requirements

The following is a list of special requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Observe motor operation and determine possible source of noise.
2. Check voltage at motor and current draw. Compare to motor ratings and the requirements of the associated equipment.
3. Perform vibration analysis on the motor.
4. Rotate motor shaft and check for binding, rubbing.
5. Measure run-out play in bearings due to wear; compare with manufacturer's specification.
6. Check alignment.
7. Shut down motor, tag and lock out disconnect.
8. Open motor and inspect interior housing for stress cracks, corrosion, other physical damage, check suspicious areas with dye penetrant.
9. Check stator windings for dirt, moisture, physical damage, signs of overheating, loose fasteners.
10. Check rotor windings for dirt, moisture, physical damage, signs of overheating, loose fasteners.
11. Check commutator/slip rings for loose parts, physical damage, wear.
12. Check brushes for wear, proper tension.
13. Check bearings for lube leakage into motor.
14. Check motor shafting for wear.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3 (Continued)

COMPONENT: MOTORS
CONTROL NUMBER: GS-III 32.05.03-3

Inspection Actions (Continued)

15. Document the problem and contact appropriate facility personnel for further instructions and reassemble motor, if directed.
16. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.
17. Ensure all guards and covers have been installed; remove tags, lockout on disconnect and restore unit to service.

Special Tools and Equipment

The following is a list of special tools and equipment beyond those listed in the Standard Tool Section.

1. Alignment Tools
2. Vibration Tester
3. Infrared Temperature Tester
4. Ammeter
5. Voltmeter
6. Dye Penetrant

Recommended Inspection Frequency

Perform inspection when triggered by Level I and Level II inspections or other local factors such as problematic conditions.

References

1. Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC, 1988

2. Electric Motor & Contracting Co. Inc., Chesapeake, VA

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 4*

COMPONENT: MOTORS
CONTROL NUMBER: GS-III 32.05.03-4*

Application

This guide applies to checking the windings of electric motors for open circuits, grounds or deteriorated insulation. Do not duplicate this effort if it is being performed under an existing base PM or recurring maintenance program.

Special Safety Requirements

The following is a list of special requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.
2. Do not use this type of instrument in an explosive atmosphere.

Inspection Actions

1. Check line voltage and ampere load for proper balance.
2. Shut down motor, tag and lockout disconnect.
3. Remove the three phase leads (load conductors) at the motor terminals or at the starter. If leads are removed at the motor, tape conductor ends. Mark leads.
4. Perform grounding and dielectric resistance test on motor windings. Values below 50 Megohms at an ambient temperature of 85 degrees F or less may indicate the presence of moisture in the winding insulation.
5. Document readings and contact appropriate facility personnel if the readings indicate a suspected problem.
6. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.
7. Make sure that leads are connected and covers have been installed; remove tags, lockout on disconnect and restore unit to service.

Special Tools and Equipment

The following is a list of special tools and equipment beyond those listed in the Standard Tool Section.

1. Megohmmeter

Recommended Inspection Frequency

Annually

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 4* (Continued)

COMPONENT: MOTORS
CONTROL NUMBER: GS-III 32.05.03-4*

References

1. The Locomotive, Vol. 69, Spring 1994, The Hartford Steam Boiler Inspection and Insurance Co., Inc.

2. Institute of Electrical and Electronic Engineers (IEEE), Specifications 112 (1984), 113 (1985) and 115 (1983)

3. National Electrical Manufactures' Association (NEMA) Book, MG 1-987, Part 12 (1987)

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 5

COMPONENT: CONTROLS
CONTROL NUMBER: GS-III 32.05.04-5

Application

This guide applies to the investigation of electrical arcing noise from the controls.

For controls in general use, Level I, II and/or III inspection methods will apply.

The Facility Manager will specify the level of inspection required for specialized control applications.

Special Safety Requirements

The following is a list of special safety requirements beyond those listed in the master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Observe control operation and determine possible source of noise.
2. Check voltage at motor and current draw. Compare to motor ratings and the requirements of the associated equipment.
3. Open and inspect local disconnect. Check for proper tension on blade-type disconnect switch, good blade alignment, signs of overheating. Tag and lock out disconnect.
4. Open and inspect motor starter. Check for contacts for pitting, good alignment, smooth action, signs of overheating.
5. Check wiring in disconnect and starter for worn, frayed insulation, loose connections.
6. Document the problem and contact appropriate facility personnel for further instructions.
7. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.
8. Remove tags, lockout on disconnect and restore unit to service.

Special Tools and Equipment

The following is a list of special tools and equipment, beyond those listed in the Standard Tool Section.

1. Infrared Temperature Tester
2. Ammeter
3. Voltmeter

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 5 (Continued)

COMPONENT: CONTROLS
CONTROL NUMBER: GS-III 32.05.04-5

Recommended Inspection Frequency

Perform inspection when triggered by Level I, Level II inspections or other local factors such as problematic conditions.

References

1. Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC 1988

2. Electric Motor & Contracting Co. Inc., Chesapeake, VA

32.06 CONDENSER WATER DISTRIBUTION SYSTEMS

DESCRIPTION

Condenser Water Distribution Systems is a subsystem of the Central Cooling Plant. The condenser water distribution system circulates treated water between the cooling generating equipment and the cooling tower, for the purpose of heat dissipation.

SPECIAL TOOL AND EQUIPMENT REQUIREMENTS

No special tools are needed for the inspection of the Condenser Water Distribution Systems, beyond the requirements listed in the Standard Tools Section.

SPECIAL SAFETY REQUIREMENTS

No special safety requirements are needed for the inspection of the Condenser Water Distribution Systems, beyond the requirements listed in the Master Safety Plan and System Safety Section.

COMPONENT LIST

- 32.06.01 PUMP BASE AND COUPLING
- 32.06.02 PUMPS
- 32.06.03 MOTORS
- 32.06.04 CONTROLS
- 32.06.05 PIPING, FITTINGS AND VALVES

RELATED SUBSYSTEMS

Due to the related nature of the elements requiring inspection, the following should be reviewed for concurrent inspection activities.

32.01	CHILLERS - ABSORPTION
32.02	CHILLERS - CENTRIFUGAL
32.03	CHILLERS - RECIPROCATING
32.04	CHILLERS - SCREW
32.07	COOLING TOWERS/EVAPORATIVE CONDENSERS

32.06 CONDENSER WATER DISTRIBUTION SYSTEMS

STANDARD INSPECTION PROCEDURE

This subsystem requires both Level I and Level II inspection as part of the basic inspection process. Additional Level II inspections may be indicated or "triggered" by the Level I inspection observation and should be accomplished by the inspector at that time.

For pumps in general use, Level I, II & III inspection methods will apply in accordance with the following gallon-per-minute ranges:

a. Use Level I inspection method if GPM is less than 40.
b. Use Level I, II and/or III inspection methods if GPM is 40 or greater.

For electric motors in general use, Level I, II & III inspection methods will apply in accordance with the following horsepower ranges:

a. Use Level I inspection method if HP is less than 15.
b. Use Level II inspection method if HP is 15 to 60.
c. Use Level III inspection method if HP is greater than 60.

The facility Manager will specify the level of inspection required for specialized pump and motor applications.

Associated defects and observations, for each major component, are listed in the inspectors' Data Collection Devices.

COMPONENTS

◆ 32.06.01 PUMP BASE AND COUPLING.

The pump base is the mounting platform for the pump and motor. The coupling is the mechanical connection between the pump and motor.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Defective mounting bolts.**			
Observation:			
a. Loose pump or motor mounting bolts.	EA		
*** {Severity M}			
b. Broken or missing pump or motor mounting bolts.	EA		
*** {Severity H}			

32.06 CONDENSER WATER DISTRIBUTION SYSTEMS

COMPONENTS (Continued)

◆ 32.06.01 PUMP BASE AND COUPLING (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Defective mounting hardware.**			
Observation:			
a. Loose base tie-down bolts.	EA		
*** {Severity M}			
b. Missing base tie-down bolts or isolators.	EA		
*** {Severity H}			
*** Defective coupling guard.**			
Observation:			
a. Loose coupling guard.	EA		
*** {Severity L}			
b. Missing coupling guard.	EA		
*** {Severity H}			
*** Defective coupling.**			
Observation:			
a. Loose set screws.	EA		
*** {Severity M}			
b. Missing set screws.		EA	
*** {Severity H}			
*** Corrosion.**			
Observation:			
a. Surface corrosion no pitting evident.	EA		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	EA		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	EA		
*** {Severity H}			
*** Abandoned pump (disconnected).**			
Observation:			
a. Inactive pump abandoned, requiring disposal.	EA		
*** {Severity L}			

32.06 CONDENSER WATER DISTRIBUTION SYSTEMS

COMPONENTS (Continued)

◆ 32.06.02 PUMPS

Pumps provide for condenser water circulation throughout the distribution system.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Damaged pump.**			
Observation:			
a. Cracked pump housing.	EA		
*** {Severity H}			
b. Broken pump base.	EA		
*** {Severity H}			
*** Leakage.**			
Observation:			
a. Leaking at pump fittings or seals.	EA		
*** {Severity H}			
b. Cracked or damaged pump housing.	EA		
*** {Severity H}			
*** Excessive noise and vibration at pump.**			
Observation:			
a. Rattling noise.	EA	1	1
*** {Severity M}			
b. Grinding noise, indicating metal to metal contact.	EA	1	1
*** {Severity H}			
*** Defective insulation.**			
Observation:			
a. Loose insulation.	SF		
*** {Severity L}			
b. Damaged or missing insulation.	SF		
*** {Severity M}			
*** Corrosion.**			
Observation:			
a. Surface corrosion no pitting evident.	EA		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	EA		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	EA		
*** {Severity H}			

32.06 CONDENSER WATER DISTRIBUTION SYSTEMS

COMPONENTS (Continued)

◆ 32.06.03 MOTORS

Electric motors are used to drive the circulating pumps. In-line circulator pumps are typically driven via spring-coupled motors, pedestal-mounted pumps are typically driven via rigid or flex-coupled motors.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Damaged motor.**			
Observation:			
a. Cracked/damaged housing or end bells.	EA		
*** {Severity H}			
b. Broken motor base.	EA		
*** {Severity H}			
*** Excessive noise and vibration.**			
Observation:			
a. Rattling noise.	EA	2	2
*** {Severity M}			
b. Grinding noise, indicating metal to metal contact.	EA	2	2
*** {Severity H}			
c. Electrical arcing noise.	EA		3
*** {Severity H}			
*** Defective electrical connectors.**			
Observation:			
a. Loose conduit or connectors.	EA		
*** {Severity M}			
b. Exposed wires or missing cover plates.	EA		
*** {Severity H}			

32.06 CONDENSER WATER DISTRIBUTION SYSTEMS

COMPONENTS (Continued)

◆ 32.06.04 CONTROLS

Controls govern the operation of the pump equipment and consist of disconnectors, starters and controllers.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Excessive noise.**			
Observation:			
a. Electrical arcing noise.	EA		5
*** {Severity H}			
*** Physically damaged control panel.**			
Observation:			
a. Control panel blocked, not accessible for inspection.	EA		
*** {Severity S}			
b. Burned out pilot lamps.	EA		
*** {Severity F}			
c. Physically damaged control panel enclosure.	EA		
*** {Severity M}			
*** Corrosion.**			
Observation:			
a. Surface corrosion no pitting evident.	EA		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	EA		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	EA		
*** {Severity H}			

32.06 CONDENSER WATER DISTRIBUTION SYSTEMS

COMPONENTS (Continued)

◆ 32.06.05 PIPING, FITTINGS AND VALVES

Piping and fittings provide the distribution network for the condenser water distribution system. Valves are installed to isolate or divert portions of the system.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Defective fitting.**			
Observation:			
a. Bent or cracked fitting, not leaking.	EA		
*** {Severity L}			
b. Water leaking.	EA		
*** {Severity H}			
*** Defective pipe.**			
Observation:			
a. Bent or cracked pipe, not leaking.	LF		
*** {Severity L}			
b. Water leaking.	LF		
*** {Severity H}			
*** Defective valves.**			
Observation:			
a. Broken or missing valve handle.	EA		
*** {Severity L}			
b. Bent stem.	EA		
*** {Severity M}			
c. Leaking valve packing glands/gaskets.	EA		
*** {Severity M}			
d. Cracked valve body.	EA		
*** {Severity H}			
*** Loose/missing supports/hangers.**			
Observation:			
a. Loose supports or hangers.	EA		
*** {Severity L}			
b. Broken/missing supports/hangers.	EA		
*** {Severity H}			

32.06 CONDENSER WATER DISTRIBUTION SYSTEMS

COMPONENTS (Continued)

◆ **32.06.05 PIPING, FITTINGS AND VALVES (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Defective insulation.**			
Observation:			
a. Loose insulation.	LF		
*** {Severity L}			
b. Damaged/missing insulation.	LF		
*** {Severity M}			
*** Corroded piping and fittings.**			
Observation:			
a. Surface corrosion (no pitting evident).	LF		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	LF		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	LF		
*** {Severity H}			
*** Corroded valves.**			
Observation:			
a. Surface corrosion no pitting evident.	EA		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	EA		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	EA		
*** {Severity H}			
*** Corroded hangers or supports.**			
Observation:			
a. Surface corrosion no pitting evident.	EA		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	EA		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	EA		
*** {Severity H}			

32.06 CONDENSER WATER DISTRIBUTION SYSTEMS

COMPONENTS (Continued)

◆ **32.06.05 PIPING, FITTINGS AND VALVES (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Defective pipe labeling.**			
Observation:			
a. Damaged/missing labels.	EA		
*** {Severity L}			

32.06 CONDENSER WATER DISTRIBUTION SYSTEMS

REFERENCES

1. NAVFAC MO-322, Vol. 2, Inspection of Shore Facilities, 1993

2. Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC, 1988

3. NAVFAC MO-209, Maintenance of Steam, Hot Water and Compressed Air Distribution Systems, 1989

4. NAVFAC P-717.0, Department of Defense, Engineered Performance Standards for Real Property Maintenance Activities

32.06 CONDENSER WATER DISTRIBUTION SYSTEMS

LEVEL II KEY	GUIDE SHEET CONTROL NUMBER
1	GS-II 32.06.02-1
2	GS-II 32.06.03-2

LEVEL III KEY	GUIDE SHEET CONTROL NUMBER
1	GS-III 32.06.02-1
2	GS-III 32.06.03-2
3	GS-III 32.06.03-3
4*	GS-III 32.06.03-4*
5	GS-III 32.06.04-5

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 1

COMPONENT: PUMPS
CONTROL NUMBER: GS-II 32.06.02-1

Application

This guide applies to the investigation of rattling and grinding (metal to metal) noise from the pump.

For pumps in general use, Level I, II & III inspection methods will apply in accordance with the following gallon-per-minute ranges:

a. Use Level I inspection method if GPM is less than 40.
b. Use Level I, II and/or III inspection methods if GPM is 40 or greater.

The Facility Manager will specify the level of inspection required for specialized pump applications.

Special Safety Requirements

The following is a list of special safety requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Observe pump operation and determine possible source of noise.
2. Shut down pump, tag and lock out disconnect.
3. Check coupling for wear, damage or loose fasteners.
4. Examine drives for alignment.
5. Turn pump by hand and determine what is causing the noise.
6. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.
7. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.
8. Ensure all guards and covers have been installed; remove tags, lockout on disconnect and restore unit to service.

Recommended Inspection Frequency

Perform inspection when triggered by a Level I or other local factors such as problematic conditions.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 1 (Continued)

COMPONENT: PUMPS
CONTROL NUMBER: GS-II 32.06.02-1

References

1. Means Facilities Maintenance Standard, Roger W. Liska, PE, AIC, I988

2. NAVFAC MO-209, Maintenance of Steam, Hot Water and Compressed Air Distribution Systems, 1989

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 2

COMPONENT: MOTORS
CONTROL NUMBER: GS-II 32.06.03-2

Application

This guide applies to the investigation of rattling and grinding (metal to metal) noise from the motor.

For electric motors in general use, Level I, II & III inspection methods will apply in accordance with the following horsepower ranges:

1. Use Level I inspection method if HP is less than 15.
2. Use Level I & II inspection methods if HP is 15 to 60.
3. Use Level I, II and/or III inspection if HP is greater than 60.

The Facility Manager will specify the level of inspection required for specialized motor applications.

Special Safety Requirements

The following is a list of special safety requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Observe motor operation and determine possible source of noise.
2. Shut down motor, tag and lock out disconnect.
3. Check coupling for wear, damage or loose fasteners.
4. Visually check interior of motor housing for other physical damage, if an open motor.
5. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.
6. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.
7. Ensure all guards and covers have been installed; remove tags, lockout on disconnect and restore unit to service.

Recommended Inspection Frequency

Perform inspection when triggered by a Level I or other local factors such as problematic conditions.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 2 (Continued)

COMPONENT: MOTORS
CONTROL NUMBER: GS-II 32.06.03-2

References

1. Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC, 1988

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1

COMPONENT: PUMPS
CONTROL NUMBER: GS-III 32.06.02-1

Application

This guide applies to the investigation of rattling and grinding (metal to metal) noise from the pump.

For pumps in general use, Level I, II & III inspection methods will apply in accordance with the following gallon-per-minute ranges:

a. Use Level I inspection method if GPM is less than 40.
b. Use Level I, II and/or III inspection methods if GPM is 40 or greater.

The Facility Manager will specify the level of inspection required for specialized pump applications.

Special Safety Requirements

The following is a list of special safety requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Observe pump operation and determine possible source of noise.
2. Perform vibration analysis on pump bearings.
3. Shut down pump, tag and lock out disconnect.
4. Isolate unit mechanically by securing air or water lines.
5. Rotate (cycle) pump to check for binding.
6. Measure run-out play in bearings due to wear; compare with manufacturer's specifications.
7. Check coupling for wear, damage, loose fasteners.
8. Check coupling for misalignment.
9. Open and inspect pump interior housing for cracks, fatigue, erosion, and corrosion, check suspicious areas.
10. Check interior shafting for signs of damage, fatigue or wear.
11. Check impellers for erosion/corrosion, physical damage, distortion.
12. Rotate (cycle) shafting and check for distortion in shaft.
13. Check clearances between impeller and wear rings; compare with manufacturer's specifications.
14. Document the problem and contact appropriate facility personnel for further instructions and reassemble pump, if directed.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1 (Continued)

COMPONENT: PUMPS
CONTROL NUMBER: GS-III 32.06.02-1

Inspection Actions (Continued)

15. Notify appropriate personnel for permission to place unit back in service if defect is not critical to continued function.
16. Ensure all guards and covers have been installed; remove tags, lockout on disconnect and restore unit to service.

Special Tools and Equipment

The following is a list of special tools and equipment, beyond those listed in the Standard Tool Section, required to perform the inspection of the pump.

1. Alignment Tools
2. Vibration Tester
3. Dye Penetrant

Recommended Inspection Frequency

Perform inspection when triggered by Level I and Level II inspections or other local factors such as problematic conditions.

References

1. Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC 1988

2 Sydnor Hydrodynamics Inc., Portsmouth, VA

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2

COMPONENT: MOTORS
CONTROL NUMBER: GS-III 32.06.03-2

Application

This guide applies to the investigation of rattling and grinding (metal to metal) noise from the motor.

For electric motors in general use, Level I, II & III inspection methods will apply in accordance with the following horsepower ranges:

1. Use Level I inspection method if HP is less than 15.
2. Use Level I & II inspection methods if HP is 15 to 60.
3. Use Level I, II and/or III inspection if HP is greater than 60.

The Facility Manager will specify the level of inspection required for specialized motor applications.

Special Safety Requirements

The following is a list of special requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Observe motor operation and determine possible source of noise.
2. Perform vibration analysis on motor bearings.
3. Shut down motor, tag and lock out disconnect.
4. Rotate (cycle) motor to check for binding.
5. Measure run-out play in bearings due to wear; compare with manufacturer's specifications.
6. Open and inspect motor interior housing for cracks, fatigue, erosion and corrosion, check suspicious areas with dye penetrant.
7. Check interior shafting for signs of fatigue or wear.
8. Rotate (cycle) shafting and check for distortion.
9. Document the problem and contact appropriate facility personnel for further instructions and reassemble motor, if directed.
10. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.
11. Ensure all guards and covers have been installed; remove tags, lockout on disconnect and restore unit to service.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2 (Continued)

COMPONENT: MOTORS
CONTROL NUMBER: GS-III 32.06.03-2

Special Tools and Equipment

The following is a list of special tools and equipment beyond those listed in the Standard Tool Section.

1. Alignment Tools
2. Vibration Tester
3. Dye Penetrant

Recommended Inspection Frequency

Perform inspection when triggered by Level I and Level II inspections or other local factors such as problematic conditions.

References

1. Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC, 1988

2. Electric Motor & Contracting Co. Inc., Chesapeake, VA

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3

COMPONENT: MOTORS
CONTROL NUMBER: GS-III 32.06.03-3

Application

This guide applies to the investigation of electrical arcing noise from the motor.

For electric motors in general use, Level I, II & III inspection methods will apply in accordance with the following horsepower ranges:

1. Use Level I inspection method if HP is less than 15.
2. Use Level I & II inspection methods if HP is 15 to 60.
3. Use Level I, II and/or III inspection if HP is 60 or greater.

The Facility Manager will specify the level of inspection required for specialized motor applications.

Special Safety Requirements

The following is a list of special requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Observe motor operation and determine possible source of noise.
2. Check voltage at motor and current draw. Compare to motor ratings and the requirements of the associated equipment.
3. Perform vibration analysis on the motor.
4. Rotate motor shaft and check for binding, rubbing.
5. Measure run-out play in bearings due to wear; compare with manufacturer's specification.
6. Check alignment.
7. Shut down motor, tag and lock out disconnect.
8. Open motor and inspect interior housing for stress cracks, corrosion, other physical damage, check suspicious areas with dye penetrant.
9. Check stator windings for dirt, moisture, physical damage, signs of overheating, loose fasteners.
10. Check rotor windings for dirt, moisture, physical damage, signs of overheating, loose fasteners.
11. Check commutator/slip rings for loose parts, physical damage, wear.
12. Check brushes for wear, proper tension.
13. Check bearings for lube leakage into motor.
14. Check motor shafting for wear.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3 (Continued)

COMPONENT: MOTORS
CONTROL NUMBER: GS-III 32.06.03-3

Inspection Actions (Continued)

15. Document the problem and contact appropriate facility personnel for further instructions and reassemble motor, if directed.
16. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.
17. Ensure all guards and covers have been installed; remove tags, lockout on disconnect and restore unit to service.

Special Tools and Equipment

The following is a list of special tools and equipment beyond those listed in the Standard Tool Section.

1. Alignment Tools
2. Vibration Tester
3. Infrared Temperature Tester
4. Ammeter
5. Voltmeter
6. Dye Penetrant

Recommended Inspection Frequency

Perform inspection when triggered by Level I and Level II inspections or other local factors such as problematic conditions.

References

1. Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC, 1988

2. Electric Motor & Contracting Co. Inc., Chesapeake, VA

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 4*

COMPONENT: MOTORS
CONTROL NUMBER: GS-III 32.06.03-4*

Application

This guide applies to checking the windings of electric motors for open circuits, grounds or deteriorated insulation. Do not duplicate this effort if it is being performed under an existing base PM or recurring maintenance program.

Special Safety Requirements

The following is a list of special requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.
2. Do not use the megohmmeter in an explosive atmosphere.

Inspection Actions

1. Check line voltage and ampere load for proper balance.
2. Shut down motor, tag and lockout disconnect.
3. Remove the three phase leads (load conductors) at the motor terminals or at the starter. If leads are removed at the motor, tape conductor ends. Mark leads.
4. Perform grounding and dielectric resistance test on motor windings. Values below 50 Megohms at an ambient temperature of 85 degrees F or less may indicate the presence of moisture in the winding insulation.
5. Document readings and contact appropriate facility personnel if the readings indicate a suspected problem.
6. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.
7. Make sure that leads are connected and covers have been installed; remove tags, lockout on disconnect and restore unit to service.

Special Tools and Equipment

The following is a list of special tools and equipment beyond those listed in the Standard Tool Section.

1. Megohmmeter

Recommended Inspection Frequency

Annually

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 4*

COMPONENT: MOTORS
CONTROL NUMBER: GS-III 32.06.03-4*

References

1. The Locomotive, Vol. 69, Spring 1994, The Hartford Steam Boiler Inspection and Insurance Co., Inc.

2. Institute of Electrical and Electronic Engineers (IEEE), Specifications 112 (1984), 113 (1985) and 115 (1983)

3. National Electrical Manufactures' Association (NEMA) Book, MG 1-987, Part 12 (1987)

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 5

COMPONENT: CONTROLS
CONTROL NUMBER: GS-III 32.06.04-5

Application

This guide applies to the investigation of electrical arcing noise from the controls.

For controls in general use, Level I, II and/or III inspection methods will apply.

The Facility Manager will specify the level of inspection required for specialized control applications.

Special Safety Requirements

The following is a list of special safety requirements beyond those listed in the master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Observe control operation and determine possible source of noise.
2. Check voltage at motor and current draw. Compare to motor ratings and the requirements of the associated equipment.
3. Open and inspect local disconnect. Check for proper tension on blade-type disconnect switch, good blade alignment, signs of overheating. Tag and lock out disconnect.
4. Open and inspect motor starter. Check contacts for pitting, good alignment, smooth action, signs of overheating.
5. Check wiring in disconnect and starter for worn, frayed insulation, loose connections.
6. Document the problem and contact appropriate facility personnel for further instructions.
7. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.
8. Remove tags, lockout on disconnect and restore unit to service.

Special Tools and Equipment

The following is a list of special tools and equipment, beyond those listed in the Standard Tool Section.

1. Infrared Temperature Tester
2. Ammeter
3. Voltmeter

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 5 (Continued)

COMPONENT: CONTROLS
CONTROL NUMBER: GS-III 32.06.04-5

Recommended Inspection Frequency

Perform inspection when triggered by Level I, Level II inspections or other local factors such as problematic conditions.

References

1. Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC 1988

2. Electric Motor & Contracting Co. Inc., Chesapeake, VA

32.07 COOLING TOWERS/EVAPORATIVE CONDENSERS

DESCRIPTION

Cooling Towers/Evaporative Condensers is a subsystem of the Central Cooling Plant. A cooling tower is a device which operates on the principle of reducing water temperature by evaporation of water in air. Water is cooled to the wet bulb temperature of the air. The water is then pumped to a remote condenser. An evaporative condenser is similar to a cooling tower except the condenser is contained in the tower and cooled water flows over the condenser.

SPECIAL TOOL AND EQUIPMENT REQUIREMENTS

The following special tools and equipment, beyond the requirements listed in the Standard Tool Section, are required to perform the inspection of the Cooling Towers/Evaporative Condensers:

1. Paintbrush
2. Dye penetrant
3. Wire Brush
4. Scraper
5. Calipers & scales
6. Hammer

SPECIAL SAFETY REQUIREMENTS

No special safety requirements are needed for the inspection of Cooling Tower/Evaporative Condensers, beyond the requirements listed in the Master Safety Plan and System Safety Section.

COMPONENT LIST

- 32.07.01 ENCLOSURES, SUPPORTS, FILL AND RESERVOIRS
- 32.07.02 FAN ASSEMBLIES
- 32.07.03 CIRCULATING PUMPS
- 32.07.04 PIPING, FITTINGS AND VALVES
- 32.07.05 DAMPERS
- 32.07.06 FLOAT VALVE
- 32.07.07 SUMP HEATERS
- 32.07.08 ACCESSIBILITY DEVICES

RELATED SUBSYSTEMS

Due to the related nature of the elements requiring inspection, the following should be reviewed for concurrent inspection activities.

32.01	CHILLERS - ABSORPTION
32.02	CHILLERS - CENTRIFUGAL
32.03	CHILLERS - RECIPROCATING
32.04	CHILLERS - SCREW

32.07 COOLING TOWERS/EVAPORATIVE CONDENSERS

32.06 CONDENSER WATER DISTRIBUTION SYSTEMS

32.07 COOLING TOWERS/EVAPORATIVE CONDENSERS

STANDARD INSPECTION PROCEDURE

This subsystem requires both Level I and Level II inspection as part of the basic inspection process. Additional Level II inspections may be indicated or "triggered" by the Level I inspection observation and should be accomplished by the inspector at that time.

For electric motors in general use, Level I, II & III inspection methods will apply in accordance with the following horsepower ranges:

a. Use Level I inspection method if HP is less than 15.
b. Use Level II inspection method if HP is 15 to 60.
c. Use Level III inspection method if HP is greater than 60.

For fans, blower assemblies in general use, Level I & II inspection methods will apply. No Level III inspection will be required.

For pumps in general use, Level I, II & III inspection methods will apply in accordance with the following gallon-per-minute ranges:

a. Use Level I inspection method if GPM is less than 40.
b. Use Level I, II and/or III inspection method if GPM is 40 or greater.

The Facility Manager will specify the level of inspection required for specialized motors, fans, blowers or blower assemblies.

Associated defects and observations, for each major component, are listed in the inspectors' Data Collection Devices.

COMPONENTS

◆ 32.07.01 ENCLOSURES, SUPPORTS, FILL AND RESERVOIRS

The enclosure is the housing for all components of the cooling tower and evaporative condenser. The supports are the structural members that support the cooling tower and evaporative condensers. The fill is the wet deck and drift eliminator. The reservoir is the cold deck at the bottom of the water tower or evaporative condenser.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Defective supports.**			
Observation:			
a. Deformation, twisting, or bending.	SF		
*** {Severity H}			
b. Physically damaged member.	SF		
*** {Severity H}			
c. Stress or fatigue cracks.	SF	1	
*** {Severity H}			

32.07 COOLING TOWERS/EVAPORATIVE CONDENSERS

COMPONENTS (Continued)

◆ 32.07.01 ENCLOSURES, SUPPORTS, FILL AND RESERVOIRS (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion of supports.**			
Observation:			
a. Surface corrosion no pitting evident.	LF		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	LF		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	LF		
*** {Severity H}			
*** Defective support connections/anchorage.**			
Observation:			
a. Loose bolts, rivets or mechanical fasteners.	EA		
*** {Severity M}			
b. Cracked or broken welds.	EA	1	
*** {Severity H}			
*** Defective enclosure panels.**			
Observation:			
a. Damaged or bent seams, no obvious water leaking.	LF		
*** {Severity L}			
b. Damaged or open seam/lap, obvious water leaking.	LF		
*** {Severity H}			
c. Loose panels.	EA		
*** {Severity H}			
d. Cracks, holes or punctures in panel, obvious water penetration.	SF		
*** {Severity H}			
e. Missing or breken panels.	SF		
*** {Severity H}			
*** Defective air intake screens.**			
Observation:			
a. Loose or bent screens.	EA		
*** {Severity L}			
b. Missing or damaged screens.	SF		
*** {Severity H}			

32.07 COOLING TOWERS/EVAPORATIVE CONDENSERS

COMPONENTS (Continued)

◆ 32.07.01 ENCLOSURES, SUPPORTS, FILL AND RESERVOIRS (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Defective panel or screen fasteners.**			
Observation:			
a. Loose fasteners.	EA		
*** {Severity M}			
b. Missing or broken fasteners.	EA		
*** {Severity H}			
*** Corrosion at enclosure panels or screens.**			
Observation:			
a. Surface corrosion no pitting evident.	EA		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	EA		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	SF		
*** {Severity H}			
*** Defective reservoir.**			
Observation:			
a. Damaged or bent seams, no obvious water leaking.	LF		
*** {Severity L}			
b. Damaged or open seam/lap, obvious water leaking.	LF		
*** {Severity H}			
*** Corrosion at metal reservoir.**			
Observation:			
a. Surface corrosion no pitting evident.	EA		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	EA		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	SF		
*** {Severity H}			

32.07 COOLING TOWERS/EVAPORATIVE CONDENSERS

COMPONENTS (Continued)

◆ 32.07.01 ENCLOSURES, SUPPORTS, FILL AND RESERVOIRS (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion at wood reservoir.**			
Observation:			
a. Wood rotted, cross section loss over 25 percent original area.	SF		1
*** {Severity M}			
b. Wood rotted, cross section loss over 50 percent original area.	SF		1
*** {Severity H}			
*** Defective fill.**			
Observation:			
a. Broken or cracked fill (ceramic, PVC, or fiberglass) not effecting flow.	SF		
*** {Severity L}			
b. Broken or cracked fill (ceramic, PVC, or fiberglass) restricting or channeling flow.	SF		
*** {Severity M}			
c. Wood fill rotted, cross section loss over 25 percent original area.	SF		
*** {Severity M}			
d. Wood fill rotted, cross section loss over 50 percent original area.	SF		
*** {Severity H}			
*** Biological fouling or scaling.**			
Observation:			
a. Film of algae or slime.	SF		
*** {Severity L}			
b. Sludge of algae or slime.	SF		
*** {Severity M}			
c. Magnesium and calcium salts deposits.	SF		
*** {Severity H}			

32.07 COOLING TOWERS/EVAPORATIVE CONDENSERS

COMPONENTS (Continued)

◆ 32.07.02 FAN ASSEMBLIES

Fan assemblies are normally used on cooling towers and evaporative condensers to increase the rate of evaporation, thereby increasing the efficiency of the unit. The fan assembly normally consists of a blower or fan, motor and drive assembly.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Excessive noise or vibration at fan/blower.**			
Observation:			
a. Rattling noise.	EA	2	
*** {Severity M}			
b. Grinding noise, indicating metal to metal contact.	EA	2	
*** {Severity H}			
c. Axial fan blade bent, damaged or vibrating.	EA		
*** {Severity H}			
*** Defective fan/blower.**			
Observation:			
a. Cracked or damaged housing.	EA		
*** {Severity M}			
b. Cracked or damaged blades.	EA		
*** {Severity H}			
*** Defective fan/blower intake dampers.**			
Observation:			
a. Inoperable dampers.	EA		
*** {Severity M}			
b. Missing dampers.	EA		
*** {Severity H}			
*** Defective mounting fan/blower hardware or supports.**			
Observation:			
a. Loose hardware or supports.	EA		
*** {Severity L}			
b. Missing or damaged hardware or supports.	EA		
*** {Severity H}			

32.07 COOLING TOWERS/EVAPORATIVE CONDENSERS

COMPONENTS (Continued)

◆ 32.07.02 FAN ASSEMBLIES (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Excessive noise or vibration at motor.**			
Observation:			
a. Rattling noise.	EA	3	
*** {Severity M}			
b. Grinding noise, indicating metal to metal contact.	EA	3	
*** {Severity H}			
c. Electrical arcing noise.	EA		
*** {Severity H}			
*** Damaged motors.**			
Observation:			
a. Cracked/damaged housing or end bells.	EA		
*** {Severity M}			
b. Broken motor base.	EA		
*** {Severity H}			
*** Defective motor mounting hardware.**			
Observation:			
a. Loose base tie-down bolts.	EA		
*** {Severity M}			
b. Missing or damaged base tie-down bolts or isolators.	EA		
*** {Severity H}			
*** Defective electrical connectors.**			
Observation:			
a. Loose conduit or connectors.	EA		
*** {Severity F}			
b. Exposed wires or missing cover plates.	EA		
*** {Severity F}			
*** Defective coupling.**			
Observation:			
a. Loose set screws.	EA		
*** {Severity M}			
b. Missing set screws.		EA	
*** {Severity H}			

32.07 COOLING TOWERS/EVAPORATIVE CONDENSERS

COMPONENTS (Continued)

◆ 32.07.02 FAN ASSEMBLIES (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Defective belt/coupling guard.**			
Observation:			
a. Loose coupling guard.	EA		
*** {Severity L}			
b. Missing or damaged belt/coupling guard.	EA		
*** {Severity S}			
*** Defective fan belts.**			
Observation:			
a. Loose fan belt.	EA		
*** {Severity F}			
b. Missing or broken fan belt.		EA	
*** {Severity F}			

32.07 COOLING TOWERS/EVAPORATIVE CONDENSERS

COMPONENTS (Continued)

◆ 32.07.03 CIRCULATING PUMPS

The evaporative condenser has a recirculation pump lifting water from the reservoir (sump) in the bottom of the unit and delivering it to the top distribution system of headers and nozzles.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Excessive noise and vibration.**			
Observation:			
a. Rattling noise at pump.	EA		
*** {Severity M}			
b. Grinding noise at pump, indicating metal to metal contact.	EA		
*** {Severity H}			
c. Electrical arcing noise (motor).	EA		
*** {Severity H}			
*** Leakage.**			
Observation:			
a. Leaking pump, fittings or seals.	EA		
*** {Severity M}			
b. Cracked or damaged pump housing.	EA		
*** {Severity M}			
*** Damaged motor/pump.**			
Observation:			
a. Cracked/damaged housing or end bells.	EA		
*** {Severity H}			
b. Broken base.	EA		
*** {Severity H}			
*** Defective mounting hardware.**			
Observation:			
a. Loose mounting bolts.	EA		
*** {Severity L}			
b. Broken or missing mounting bolts.	EA		
*** {Severity H}			
*** Defective electrical connectors.**			
Observation:			
a. Loose conduit or connectors.	EA		
*** {Severity F}			
b. Exposed wires or missing cover plates.	EA		
*** {Severity F}			

32.07 COOLING TOWERS/EVAPORATIVE CONDENSERS

32.07 COOLING TOWERS/EVAPORATIVE CONDENSERS

COMPONENTS (Continued)

◆ 32.07.04 PIPING, FITTINGS AND VALVES

Piping, fittings and valves that are part of the evaporative condensers, pertain to the water lifting system from the reservoir to the headers and nozzles.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Leaking/damaged fittings.**			
Observation:			
a. Bent or cracked fitting, not leaking.	EA		
*** {Severity L}			
b. Water leaking.	EA		
*** {Severity H}			
*** Leaking/damaged pipe.**			
Observation:			
a. Bent or cracked pipe, not leaking.	LF		
*** {Severity L}			
b. Water leaking.	LF		
*** {Severity H}			
*** Leaking/damaged valves.**			
Observation:			
a. Broken or missing valve handle.	EA		
*** {Severity L}			
b. Bent stem.	EA		
*** {Severity M}			
c. Leaking valve packing glands/gaskets.	EA		
*** {Severity M}			
d. Cracked valve body.	EA		
*** {Severity}			
*** Loose/missing supports/hangers.**			
Observation:			
a. Loose supports or hangers.	EA		
*** {Severity L}			
b. Broken/missing supports/hangers.	EA		
*** {Severity H}			
*** Defective pipe labeling.**			
Observation:			
a. Damaged/missing labels.	EA		
*** {Severity L}			

32.07 COOLING TOWERS/EVAPORATIVE CONDENSERS

COMPONENTS (Continued)

◆ **32.07.04 PIPING, FITTINGS AND VALVES (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corroded piping and fittings.**			
Observation:			
a. Surface corrosion (no pitting evident).	LF		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	LF		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	LF		
*** {Severity H}			
*** Leaking valve.**			
Observation:			
a. Leaking check valve.	EA		
*** {Severity L}			
b. Leaking valve packing glands/gaskets.	EA		
*** {Severity M}			
*** Defective insulation.**			
Observation:			
a. Loose insulation.	LF		
*** {Severity L}			
b. Damaged or missing insulation.	LF		
*** {Severity H}			
c. Missing insulation.	LF		
*** {Severity H}			
*** Corroded valves.**			
Observation:			
a. Surface corrosion no pitting evident.	EA		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	EA		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	EA		
*** {Severity H}			

32.07 COOLING TOWERS/EVAPORATIVE CONDENSERS

COMPONENTS (Continued)

◆ **32.07.04 PIPING, FITTINGS AND VALVES (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corroded hangers or supports.**			
Observation:			
a. Surface corrosion (no pitting evident).	EA		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	EA		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of holes or loss of base metal.	EA		
*** {Severity H}			

32.07 COOLING TOWERS/EVAPORATIVE CONDENSERS

COMPONENTS (Continued)

◆ 32.07.05 DAMPERS

Installations requiring close temperature controls employ a centrifugal fan equipped with capacity control dampers. The damper is a single air foil blade located in the fan discharge and may be manual or connected with a standard electric control package.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Damper binding or hanging up.**			
Observation:			
a. Damper loaded up with dirt.	SF		
*** {Severity L}			
b. Damper/control linkage bent or damaged.	SF		
*** {Severity H}			
c. Broken or missing damper.	SF		
*** {Severity H}			
*** Corrosion.**			
Observation:			
a. Surface corrosion no pitting evident.	SF		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	SF		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	SF		
*** {Severity H}			

32.07 COOLING TOWERS/EVAPORATIVE CONDENSERS

COMPONENTS (Continued)

◆ 32.07.06 FLOAT VALVE

The float valve is installed in the reservoir to replenish and regulate the water level. It consist of a float actuator and water supply valve.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Defective float valve.**			
Observation:			
a. Mineral build-up on the float or valve, still operable.	EA		
*** {Severity L}			
b. Float bulb leaking and/or submerged.	EA		
*** {Severity H}			
c. Valve leaking, water flowing in overflow.	EA		
*** {Severity H}			
d. Valve inoperable, reservoir dry.	EA		
*** {Severity H}			

32.07 COOLING TOWERS/EVAPORATIVE CONDENSERS

COMPONENTS (Continued)

◆ 32.07.07 SUMP HEATERS

Sump heaters are provided to prevent the reservoir water from freezing.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Defective electric heating element.**			
Observation:			
a. Inoperable.	EA		
*** {Severity H}			
b. Missing.	EA		
*** {Severity H}			
*** Defective steam modulating valve.**			
Observation:			
a. Disconnected or missing modulating valve sensor.	EA		
*** {Severity H}			
*** Defective electrical connectors.**			
Observation:			
a. Loose conduit or connectors.	EA		
*** {Severity F}			
b. Exposed wires or missing cover plates.	EA		
*** {Severity F}			

32.07 COOLING TOWERS/EVAPORATIVE CONDENSERS

COMPONENTS (Continued)

◆ 32.07.08 ACCESSIBILITY DEVICES

Stairways, ladders and walkways are provided for access to the interior and the fan deck. These may be wood or metal to be compatible with the construction material. Ladders for towers with the fan deck 20' or more above the basin curb will be furnished with a metal safety cage. The fan deck walkways are guarded by railings.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Defective connections, anchorage or supports.**			
Observation:			
a. Missing or loose belts/fastners.	EA		
*** {Severity H}			
b. Loose, rotten, broken or split (wood).	EA		
*** {Severity H}			
c. Brackets corroded beyond repair.	EA		
*** {Severity H}			
d. Impact damage, broken brackets.	EA		
*** {Severity H}			
*** Cracking or buckling of frame (metal).**			
Observation:			
a. Deformation, twisting, or bending.	LF		
*** {Severity H}			
b. Physically damaged member.	LF		
*** {Severity H}			
c. Stress or fatigue cracks.	LF	4	
*** {Severity H}			
d. Missing rungs.	EA		
*** {Severity H}			
*** Split, cracked or broken members (wood).**			
Observation:			
a. Surface fibers separated, less than 25 percent of thickness affected.	LF		
*** {Severity M}			
b. Surface fibers separated, greater than 25 percent of thickness affected.	LF		
*** {Severity H}			
c. Physically damaged, broken or deflected.	LF		
*** {Severity H}			
d. Missing rungs.	EA		
*** {Severity H}			

32.07 COOLING TOWERS/EVAPORATIVE CONDENSERS

COMPONENTS (Continued)

◆ **32.07.08 ACCESSIBILITY DEVICES (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Rot, fungus or decay (wood).**			
Observation:			
a. Moist stained area.	SF		
*** {Severity M}			
b. Discolored, soft or crushed area.	SF	56	
*** {Severity H}			
*** Corrosion (metal).**			
Observation:			
a. Surface corrosion no pitting evident.	LF		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	LF		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	LF		
*** {Severity H}			

32.07 COOLING TOWERS/EVAPORATIVE CONDENSERS

REFERENCES

1. TRANE Air Conditioning Manual, 67th Printing Nov. 93, McGill Graphic Arts
2. Architectural Graphic Standards, Seventh Edition, Ramsey Sleeper, 1981
3. Building Design and Construction Handbook, Fourth Edition, McGraw-Hill, 1982
4. Handbook of Fundamentals, ASHRAE, 1985
5. NAVFAC MO-144, Vol. 3, 1989

32.07 COOLING TOWERS/EVAPORATIVE CONDENSERS

LEVEL II KEY	GUIDE SHEET CONTROL NUMBER
1	GS-II 32.07.01-1
2	GS-II 32.07.02-2
3	GS-II 32.07.02-3
4	GS-II 32.07.08-4
5	GS-II 32.07.08-5

LEVEL III KEY	GUIDE SHEET CONTROL NUMBER
1	GS-III 32.07.01-1

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 1

COMPONENT: ENCLOSURES, SUPPORTS, FILL AND RESERVOIRS
CONTROL NUMBER: GS-II 32.07.01-1

Application

This guide applies to the investigation of cracks or cracked welds in metal enclosures, supports and reservoirs.

Special Safety Requirements

No special safety requirements are needed for the performance of the Level II inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Clean area (wire brush) to bare metal.
2. Apply dye, allow to penetrate, remove excess.
3. Apply developer, this draws the dye out and defines the extent and size of surface flaws.

Recommended Inspection Frequency

Annually

References

1. Architectural Graphic Standards, Seventh Edition, Rampsey/Sleeper, 1981

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 2

COMPONENT: FAN ASSEMBLIES
CONTROL NUMBER: GS-II 32.07.02-2

Application

This guide applies to the investigation of rattling and grinding (metal to metal) noise from the fans/blowers.

For fans, blowers and blower assemblies in general use, Level I and II inspection methods will apply. No Level III inspection will be required.

The Facility Manager will specify the level of inspection required for specialized fans, blowers or blower assemblies.

Special Safety Requirements

The following is a list of special safety requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.
2. Always have one person standing by outside when someone is working inside a walk-in unit.

Inspection Actions

1. Observe operation and determine possible source of noise.
2. Shut down, tag and lock out disconnect.
3. Remove access plates.
4. Check assembly for wear, damage or loose fasteners.
5. Visually inspect blading for foreign objects and deposit buildup.
6. Inspect blading for cracks, fatigue, physical damage and corrosion.
7. Rotate shafting and check for distortion in shaft.
8. Rotate to check for binding.
9. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.
10. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.
11. Ensure all guards and covers have been installed; remove tags, lockout on disconnect and restore unit to service.

Recommended Inspection Frequency

Perform inspection when triggered by a Level I or other local factors such as problematic conditions.

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 2 (Continued)

COMPONENT: FAN ASSEMBLIES
CONTROL NUMBER: GS-II 32.07.02-2

References

1. Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC, 1988

2. NAVFAC MO-114, Maintenance and Operations of Ventilation Systems, 1989

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 3

COMPONENT: FAN ASSEMBLIES
CONTROL NUMBER: GS-II 32.07.02-3

Application

This guide applies to the investigation of rattling and grinding (metal to metal) noise from the fan motor.

For electric motors in general use, Level I & II inspection methods will apply in accordance with the following horsepower ranges:

1. Use Level I inspection method if HP is less than 15.
2. Use Level I & II inspection methods if HP is 15 or greater.

The Facility Manager will specify the level of inspection required for specialized motor applications.

Special Safety Requirements

The following is a list of special safety requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Observe motor operation and determine possible source of noise.
2. Shut down motor, tag and lock out disconnect.
3. Check coupling for wear, damage or loose fasteners.
4. Visually check interior of motor housing for other physical damage, if an open motor.
5. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.
6. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.
7. Ensure all guards and covers have been installed; remove tags, lockout on disconnect and restore unit to service.

Recommended Inspection Frequency

Perform inspection when triggered by a Level I or other local factors such as problematic conditions.

References

1. Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC, 1988

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 4

COMPONENT: ACCESSIBILITY DEVICES
CONTROL NUMBER: GS-II 32.07.08-4

Application

This guide applies to the investigation of cracks or cracked welds in metal ladders, stairways, and railings.

Special Safety Requirements

No special safety requirements are needed for the performance of the Level II inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Clean area (wire brush) to bare metal.
2. Apply dye, allow to penetrate, remove excess.
3. Apply developer, this draws the dye out and defines the extent and size of surface flaws.

Recommended Inspection Frequency

Annually

References

1. Architectural Graphic Standards, Seventh Edition, Rampsey/Sleeper, 1981

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 5

COMPONENT: ACCESSIBILITY DEVICES
CONTROL NUMBER: GS-II 32.07.08-5

Application

This guide applies to the investigation of deterioration of wood handrails, stairways, walkways and ladders due to insect infestation, rot, or fungi damage.

Special Safety Requirements

No special safety requirements are needed for the performance of the Level II inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Clean affected area using scraper and brush.
2. Utilize calipers and scales to determine an approximation of the area that has been lost due to deterioration.
3. Tap with hammer in order to detect loss of interior material, evidenced by a hollow sound.
4. Probe with ice pick or pocket knife to determine extent of damage due to insect infestation, rot or fungi damage.

Recommended Inspection Frequency

Annually

References

1. Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC, 1988
2. NAVFAC MO-312, Wood Protection, 1990

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1

COMPONENT: ENCLOSURES, SUPPORTS, FILL AND RESERVOIRS
CONTROL NUMBER: GS-III 32.07.01-1

Application

This guide applies to the investigation of deterioration of wood members due to insect infestation, rot or fungi damage.

Special Safety Requirements

No special safety requirements are needed for the performance of the Level II inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Shut down unit, tag and lock out disconnect. Drain reservoir.
2. Clean affected area using scraper and brush.
3. Utilize calipers and scales to determine an approximation of the area that has been lost due to deterioration.
4. Tap with hammer in order to detect loss of interior material, evidenced by a hollow sound.
5. Probe with ice pick or pocket knife to determine extent of damage due to insect infestation, rot or fungi damage.
6. Document the problem and contact appropriate facility personnel for further instructions, if defect is major.
7. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.
8. Remove tags, lockout on disconnect an restore unit to service.

Special Tools and Equipment

The following is a list of special tools and equipment, beyond those listed in the Standard Tool Section.

1. Scraper
2. Brush
3. Calipers
4. Hammer

Recommended Inspection Frequency

Annually

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1

COMPONENT: ENCLOSURES, SUPPORTS, FILL AND RESERVOIRS
CONTROL NUMBER: GS-III 32.07.01-1

References

1. Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC, 1988

2. NAVFAC MO-312, Wood Protection, 1990

32.08 AIR COOLED CONDENSER - FLUID COOLERS SYSTEMS

DESCRIPTION

Air Cooled Condenser - Fluid Coolers Systems is a subsystem of the Central Cooling Plant. Air cooled condenser DX systems normally consist of an air cooled condenser coil and fans. Fluid cooler systems, for water or glycol systems, normally consist of an air cooled condenser coil, fans, dampers, a pump and an expansion tank.

SPECIAL TOOL AND EQUIPMENT REQUIREMENTS

No special tools are needed for the inspection of Air Cooled Condenser - Fluid Coolers Systems, beyond the requirements listed in the Standard Tools Section.

SPECIAL SAFETY REQUIREMENTS

No special safety requirements are needed for the performance of the Level II inspection beyond those listed in the Master Safety Plan and System Safety Section.

COMPONENT LIST

- 32.08.01 AIR COOLED CONDENSER - FLUID COOLER
- 32.08.02 CIRCULATING PUMPS AND MOTORS
- 32.08.03 EXPANSION TANKS

RELATED SUBSYSTEMS

Due to the related nature of the elements requiring inspection, the following should be reviewed for concurrent inspection activities.

32.01	CHILLERS - ABSORPTION
32.02	CHILLERS - CENTRIFUGAL
32.03	CHILLERS - RECIPROCATING
32.04	CHILLERS - SCREW

32.08 AIR COOLED CONDENSER - FLUID COOLERS SYSTEMS

STANDARD INSPECTION PROCEDURE

This subsystem requires a Level I and Level II inspection as part of the basic inspection process. Additional Level II inspections may be indicated or "triggered" by the Level I inspection observation and should be accomplished by the inspector at that time.

For electric motors in general use, Level I and II inspection methods will apply in accordance with the following horsepower ranges:

a. Use Level I inspection method if HP is less than 15.
b. Use Level II inspection method if HP is 15 or greater.

For fans, blower assemblies in general use, Level I & II inspection methods will apply. No Level III inspection will be required.

For pumps in general use, Level I, II & III inspection methods will apply in accordance with the following gallon-per-minute ranges:

a. Use Level I inspection method if GPM is less than 40.
b. Use Level I, II and/or III inspection methods if GPM is 40 or greater.

The Facility Manager will specify the level of inspection required for specialized motors, fans, blowers or blower assemblies.

Associated defects and observations, for each major component, are listed in the inspectors' Data Collection Devices.

COMPONENTS

◆ 32.08.01 AIR COOLED CONDENSER - FLUID COOLER

The air cooled condenser removes the heat from the high pressure refrigeration gas. The fluid cooler removes heat from the high temperature condenser water or glycol. The units contain fin tube coils, fans and dampers.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Leakage at coil.**			
Observation:			
a. Evidence of refrigerant leakage.	EA		
*** {Severity H}			
b. Evidence of water or glycol leakage.	EA		
*** {Severity H}			

32.08 AIR COOLED CONDENSER - FLUID COOLERS SYSTEMS

COMPONENTS (Continued)

◆ 32.08.01 AIR COOLED CONDENSER - FLUID COOLER (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Deteriorated/clogged coils.**			
Observation:			
a. Dust/debris accumulation on coils.	SF		
*** {Severity F}			
b. Damaged/eroded coils.	SF		
*** {Severity H}			
*** Excessive noise or vibration at fan.**			
Observation:			
a. Rattling noise.	EA		
*** {Severity M}			
b. Grinding noise, indicating metal to metal contact.	EA		
*** {Severity H}			
c. Axial fan blade bent, damaged or vibrating.	EA		
*** {Severity H}			
*** Defective fan.**			
Observation:			
a. Cracked or damaged housing.	EA		
*** {Severity M}			
b. Cracked or damaged blades.	EA		
*** {Severity H}			
*** Defective fan mounting hardware or supports.**			
Observation:			
a. Loose hardware or supports.	EA		
*** {Severity L}			
b. Missing or damaged hardware or supports.	EA		
*** {Severity M}			
*** Excessive noise or vibration at motor.**			
Observation:			
a. Rattling noise.	EA		
*** {Severity M}			
b. Grinding noise, indicating metal to metal contact.	EA		
*** {Severity H}			

32.08 AIR COOLED CONDENSER - FLUID COOLERS SYSTEMS

COMPONENTS (Continued)

◆ 32.08.01 AIR COOLED CONDENSER - FLUID COOLER (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Damaged motors.**			
Observation:			
a. Cracked/damaged housing or end bells.	EA		
*** {Severity M}			
b. Broken motor base.	EA		
*** {Severity H}			
*** Defective motor mounting hardware.**			
Observation:			
a. Loose base tie-down bolts.	EA		
*** {Severity M}			
b. Missing or damaged base tie-down bolts or isolators.	EA		
*** {Severity H}			
*** Defective electrical connectors.**			
Observation:			
a. Loose conduit or connectors.	EA		
*** {Severity M}			
b. Exposed wires or missing cover plates.	EA		
*** {Severity H}			
*** Defective dampers.**			
Observation:			
a. Loose operator or damper linkage.	EA		
*** {Severity M}			
b. Broken or missing dampers.	SF		
*** {Severity H}			
*** Damaged enclosures.**			
Observation:			
a. Loose enclosure panels.	EA		
*** {Severity L}			
b. Missing or damaged enclosure panels.	SF		
*** {Severity H}			

32.08 AIR COOLED CONDENSER - FLUID COOLERS SYSTEMS

COMPONENTS (Continued)

◆ 32.08.01 AIR COOLED CONDENSER - FLUID COOLER (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion at dampers.**			
Observation:			
a. Surface corrosion no pitting evident	SF		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering	SF		
*** {Severity M}			
c. Corrosion evidenced by holes or lose of base metal.	SF		
*** {Severity H}			
*** Corrosion at enclosure.**			
Observation:			
a. Surface corrosion (no pitting evident	SF		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	SF		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	SF		
*** {Severity H}			

32.08 AIR COOLED CONDENSER - FLUID COOLERS SYSTEMS

COMPONENTS (Continued)

◆ 32.08.02 CIRCULATING PUMPS AND MOTORS

Pumps provide for fluid circulation throughout the fluid cooling system.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Excessive noise and vibration.**			
Observation:			
a. Rattling noise at pump.	EA	1	1
*** {Severity M}			
b. Grinding noise at pump, indicating metal to metal contact.	EA	1	1
*** {Severity H}			
*** Leakage.**			
Observation:			
a. Leaking pump, fittings or seals.	EA		
*** {Severity M}			
b. Cracked or damaged pump housing.	EA		
*** {Severity M}			
*** Damaged motor.**			
Observation:			
a. Cracked/damaged housing or end bells.	EA		
*** {Severity H}			
b. Broken base.	EA		
*** {Severity H}			
*** Defective mounting hardware.**			
Observation:			
a. Loose mounting bolts.	EA		
*** {Severity L}			
b. Broken or missing mounting bolts.	EA		
*** {Severity H}			
*** Defective electrical connectors.**			
Observation:			
a. Loose conduit or connectors.	EA		
*** {Severity M}			
b. Exposed wires or missing cover plates.	EA		
*** {Severity H}			

32.08 AIR COOLED CONDENSER - FLUID COOLERS SYSTEMS

COMPONENTS (Continued)

◆ 32.08.03 EXPANSION TANKS

Expansion tanks are closed steel containers that are used to compensate for the change in liquid volume caused by the system temperature variation. Expansion tanks are normally installed at highest point in the system.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Physical damage.**			
Observation:			
a. Abrasions.	SF		
*** {Severity L}			
b. Impact damage, dents.	SF		
*** {Severity M}			
*** Leakage.**			
Observation:			
a. Liquid dripping from tank fitting.	EA		
*** {Severity L}			
b. Leakage at tank seams.	EA		
*** {Severity H}			
*** Defective mounting hardware or supports.**			
Observation:			
a. Loose hardware or supports.	EA		
*** {Severity L}			
b. Damaged hardware or supports.	EA		
*** {Severity M}			
c. Missing hardware or supports.	EA		
*** {Severity H}			
*** Corrosion.**			
Observation:			
a. Surface corrosion (no pitting evident}.	SF		
*** {Severity L}			
b. Corrosion evident by pitting or blistering.	SF		
*** {Severity M}			
c. Corrosion evident by holes or loss of base metal.	SF		
*** {Severity H}			

32.08 AIR COOLED CONDENSER - FLUID COOLERS SYSTEMS

REFERENCES

1. NAVFAC MO-322, Vol.2, Inspection of Shore Facilities, 1993
2. Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC, 1988
3. Liebert Corporation, Heat Rejection, General Data - Bulletin No. SL-10055, 1986
4. Liebert Corporation, Air Cooled Condensers - Bulletin No. SL-10057, 1988
5. Liebert Corporation, Dry Coolers - Bulletin No. SL-10058, 1987

32.08 AIR COOLED CONDENSER - FLUID COOLERS SYSTEMS

LEVEL II KEY	GUIDE SHEET CONTROL NUMBER
1	GS-II 32.08.02-1

LEVEL III KEY	GUIDE SHEET CONTROL NUMBER
1	GS-III 32.08.02-1

LEVEL II INSPECTION METHOD GUIDE SHEET

LEVEL II GUIDE SHEET - KEY NO. 1

COMPONENT: CIRCULATING PUMPS AND MOTORS
CONTROL NUMBER: GS-II 32.08.02-1

Application

This guide applies to the investigation of rattling and grinding (metal to metal) noise from the pump.

For pumps in general use, Level I, II & III inspection methods will apply in accordance with the following gallon-per-minute ranges:

a. Use Level I inspection method if GPM is less than 40.
b. Use Level I, II and/or III inspection methods if GPM is 40 or greater.

The Facility Manager will specify the level of inspection required for specialized pump applications.

Special Safety Requirements

The following is a list of special safety requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Observe pump operation and determine possible source of noise.
2. Shut down pump, tag and lock out disconnect.
3. Check coupling for wear, damage or loose fasteners.
4. Examine drives for alignment.
5. Turn pump by hand and determine what is causing the noise.
6. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.
7. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.
8. Ensure all guards and covers have been installed; remove tags, lockout on disconnect and restore unit to service.

Recommended Inspection Frequency

Perform inspection when triggered by a Level I or other local factors such as problematic conditions.

References

1. Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC, 1988

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1

COMPONENT: CIRCULATING PUMPS AND MOTORS
CONTROL NUMBER: GS-III 32.08.02-1

Application

This guide applies to the investigation of rattling and grinding (metal to metal) noise from the pump.

For pumps in general use, Level I, II & III inspection methods will apply in accordance with the following gallon-per-minute ranges:

a. Use Level I inspection method if GPM is less than 40.
b. Use Level I, II and/or III inspection methods if GPM is 40 or greater.

The Facility Manager will specify the level of inspection required for specialized pump applications.

Special Safety Requirements

The following is a list of special safety requirements beyond those listed in the Master Safety Plan and System Safety Section.

1. Notify affected personnel and obtain permission to take unit out of service.

Inspection Actions

1. Observe pump operation and determine possible source of noise.
2. Perform vibration analysis on pump bearings.
3. Shut down pump, tag and lock out disconnect.
4. Isolate unit mechanically by securing air or water lines.
5. Rotate (cycle) pump to check for binding.
6. Measure run-out play in bearings due to wear; compare with manufacturer's specifications.
7. Check coupling for wear, damage, loose fasteners.
8. Check coupling for misalignment.
9. Open and inspect pump interior housing for cracks, fatigue, erosion, and corrosion, check suspicious areas.
10. Check interior shafting for signs of damage, fatigue or wear.
11. Check impellers for erosion/corrosion, physical damage, distortion.
12. Rotate (cycle) shafting and check for distortion in shaft.
13. Check clearances between impeller and wear rings; compare with manufacturer's specifications.
14. Document the problem and contact appropriate facility personnel for further instructions and reassemble pump, if directed.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1 (Continued)

COMPONENT: CIRCULATING PUMPS AND MOTORS
CONTROL NUMBER: GS-III 32.08.02-1

Inspection Actions (Continued)

15. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.
16. Ensure all guards and covers have been installed; remove tags, lockout on disconnect and restore unit to service.

Special Tools and Equipment

The following is a list of special tools and equipment, beyond those listed in the Standard Tool Section.

1. Alignment Tools
2. Vibration Tester
3. Dye Penetrant

Recommended Inspection Frequency

Perform inspection when triggered by Level I and Level II inspections or other local factors such as problematic conditions.

References

1. Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC, 1988

2. Sydnor Hydrodynamics Inc., Portsmouth, VA

32.09 CHEMICAL WATER TREATMENT SYSTEMS

DESCRIPTION

Chemical Water Treatment Systems is a subsystem of the Central Cooling Plants. Chemical water treatment systems inhibit the development of scale, corrosion and biological growth within the cooling towers, chilled and condenser water distribution systems. The typical system consists of chemical tank, metering pump and the connecting piping, fittings, valves and instrumentation.

SPECIAL TOOL AND EQUIPMENT REQUIREMENTS

No special tools are needed for the inspection of Chemical Water Treatment Systems, beyond the requirements listed in the Standard Tools Section.

SPECIAL SAFETY REQUIREMENTS

No special safety requirements are needed for the inspection of Chemical Water Treatment Systems, beyond the requirements listed in the Master Safety Plan and System Safety Section.

COMPONENT LIST

- 32.09.01 COOLING TOWER WATER CHEMICAL TREATMENT SYSTEMS
- 32.09.02 CLOSED-LOOP WATER CHEMICAL TREATMENT SYSTEMS

RELATED SUBSYSTEMS

Due to the related nature of the elements requiring inspection, the following should be reviewed for concurrent inspection activities.

32.05 CHILLED WATER DISTRIBUTION SYSTEMS
32.06 CONDENSER WATER DISTRIBUTION SYSTEMS

32.09 CHEMICAL WATER TREATMENT SYSTEMS

STANDARD INSPECTION PROCEDURE

This subsystem requires a Level I inspection as part of the basic inspection process. Associated defects and observations, for each major component, are listed in the inspectors' Data Collection Devices.

COMPONENTS

◆ 32.09.01 COOLING TOWER WATER CHEMICAL TREATMENT SYSTEMS

Cooling tower water chemical treatment systems inhibit corrosion and deposits within the open recirculating system. Water treatment also controls chemical and biological surface attack on condenser tubes and cooling tower wood in flooded portions of the tower.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Defective chemical storage tanks.**			
Observation:			
a. Physical damage to storage tank.	EA		
*** {Severity M}			
b. Leaking storage tank.	EA		
*** {Severity H}			
*** Defective pumps.**			
Observation:			
a. Deposit build-up.	EA		
*** {Severity M}			
b. Excessive corrosion.	EA		
*** {Severity H}			
c. Leaking pump.	EA		
*** {Severity H}			
*** Defective controller.**			
Observation:			
a. Broken glass panel on controller door.	EA		
*** {Severity M}			
b. Controller disconnected or missing.	EA		
*** {Severity H}			
*** Defective electrical connectors.**			
Observation:			
a. Loose conduit or connectors.	EA		
*** {Severity M}			
b. Exposed wires or missing cover plates.	EA		
*** {Severity H}			

32.09 CHEMICAL WATER TREATMENT SYSTEMS

COMPONENTS (Continued)

◆ 32.09.02 CLOSED-LOOP WATER CHEMICAL TREATMENT SYSTEMS

Chemical treatment of closed-loop systems inhibit corrosion and deposit build-up caused by the addition of raw make-up water to the closed-loop system.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Shot tank corrosion.**			
Observation:			
a. Surface corrosion no pitting evident.	EA		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	EA		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	EA		
*** {Severity H}			

32.09 CHEMICAL WATER TREATMENT SYSTEMS

REFERENCES

1. Modern Refrigeration and Air Conditioning, The Goodheart-Wilcox Company, Inc.,1968

2. FSC: HVAC Water Treatment Maintenance and Repair, PWC, 1991

3. Baltimore Aircoil Company, Baltimore, MD, 21227

4. NAVFAC MO-225, Industrial Water Treatment, 1990

32.09 CHEMICAL WATER TREATMENT SYSTEMS

LEVEL II KEY **GUIDE SHEET CONTROL NUMBER**

N/A

LEVEL III KEY **GUIDE SHEET CONTROL NUMBER**

N/A

32.10 STEAM DISTRIBUTION SYSTEMS

DESCRIPTION

Steam Distribution Systems is a subsystem of the Central Cooling Plants. The Steam Distribution System provides steam circulation between the exterior steam distribution system and the steam fired absorption chiller.

SPECIAL TOOL AND EQUIPMENT REQUIREMENTS

No special tools are needed for the inspection of Steam Distribution Systems, beyond the requirements listed in the Standard Tools Section.

SPECIAL SAFETY REQUIREMENTS

No special safety requirements are needed for the inspection of Steam Distribution Systems, beyond the requirements listed in the Master Plan and System Safety Section.

COMPONENT LIST

- 32.10.01 PIPING, FITTINGS AND VALVES
- 32.10.02 PRESSURE REDUCING STATIONS
- 32.10.03 STEAM TRAPS

RELATED SUBSYSTEMS

Due to the related nature of the elements requiring inspection, the following equipment should be reviewed for concurrent inspection activities.

23.07	STEAM DISTRIBUTION SYSTEMS
23.08	STEAM CONDENSATE RETURN SYSTEMS
32.01	CHILLERS - ABSORPTION
32.11	STEAM CONDENSATE RETURN SYSTEMS

32.10 STEAM DISTRIBUTION SYSTEMS

STANDARD INSPECTION PROCEDURE

This subsystem requires a Level I inspections as part of the basic inspection process. Level III inspections may be indicated or "triggered" by the Level I inspection observation. Associated defects and observations, for each major component, are listed in the inspectors' Data Collection Devices.

COMPONENTS

◆ 32.10.01 PIPING, FITTINGS AND VALVES

Piping and fittings provide the distribution network for the steam distribution system. Valves are installed to control the steam distribution supply and isolate system parts.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Leaking/damaged fitting.**			
Observation:			
a. Bent or cracked fitting, not leaking.	EA		
*** {Severity L}			
b. Steam leaking.	EA		
*** {Severity H}			
*** Leaking/damaged pipe.**			
Observation:			
a. Bent or cracked pipe, not leaking.	LF		
*** {Severity L}			
b. Steam leaking.	LF		
*** {Severity H}			
*** Plugged strainer.**			
Observation:			
a. Temperature difference between inlet and outlet of strainer.	EA		1
*** {Severity H}			
*** Damaged/defective strainer.**			
Observation:			
a. Cracked strainer, not leaking.	EA		
*** {Severity M}			
b. Cracked strainer, steam leaking.	EA		
*** {Severity H}			

32.10 STEAM DISTRIBUTION SYSTEMS

COMPONENTS (Continued)

◆ 32.10.01 PIPING, FITTINGS AND VALVES (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Loose/missing supports/hangers.**			
Observation:			
a. Loose supports or hangers.	EA		
*** {Severity L}			
b. Broken/missing supports/hangers.	EA		
*** {Severity H}			
*** Defective insulation.**			
Observation:			
a. Loose insulation.	LF		
*** {Severity L}			
b. Damaged or missing insulation.	LF		
*** {Severity H}			
*** Defective valve.**			
Observation:			
a. Broken/missing valve handle.	EA		
*** {Severity L}			
b. Bent stem.	EA		
*** {Severity M}			
c. Leaking valve.	EA		
*** {Severity M}			
d. Cracked valve body.	EA		
*** {Severity H}			
e. Inoperable valve.	EA		
*** {Severity H}			
*** Corroded piping and fittings.**			
Observation:			
a. Surface corrosion (no pitting evident).	LF		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	LF		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	LF		
*** {Severity H}			

32.10 STEAM DISTRIBUTION SYSTEMS

COMPONENTS (Continued)

◆ **32.10.01 PIPING, FITTINGS AND VALVES (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corroded valves/stainers.**			
Observation:			
a. Surface corrosion (no pitting evident).	EA		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	EA		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	EA		
*** {Severity H}			
*** Defective pipe labeling.**			
Observation:			
a. Damaged or missing labels.	EA		
*** {Severity L}			

32.10 STEAM DISTRIBUTION SYSTEMS

COMPONENTS (Continued)

◆ 32.10.02 PRESSURE REDUCING STATIONS

Pressure reducing stations are used to reduce the pressure of a steam source to a desired operational level.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Defective reducing valve.**			
Observation:			
a. Inoperable reducing valve, upstream and downstream gauges indicating same pressure.	EA		
*** {Severity H}			
*** Damaged safety valve.**			
Observation:			
a. Missing or broken lift handle.	EA		
*** {Severity M}			
b. Leaking safety valve.	EA		
*** {Severity H}			
c. Broken calibration seal.	EA		
*** {Severity H}			
d. Tied-down lift handle.	EA		
*** {Severity H}			
e. Missing vent pipe.	EA		
*** {Severity H}			
f. Bent stem.	EA		
*** {Severity H}			
*** Leaking/damaged fitting.**			
Observation:			
a. Bent/cracked fitting, not leaking.	EA		
*** {Severity M}			
b. Steam leaking.	EA		
*** {Severity H}			
*** Leaking/damaged pipe.**			
Observation:			
a. Bent/cracked pipe, not leaking.	LF		
*** {Severity M}			
b. Steam leaking.	LF		
*** {Severity H}			

32.10 STEAM DISTRIBUTION SYSTEMS

COMPONENTS (Continued)

◆ **32.10.02 PRESSURE REDUCING STATIONS (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Damaged valves.**			
Observation:			
a. Broken/missing handle.	EA		
*** {Severity L}			
b. Bent stem.	EA		
*** {Severity M}			
c. Cracked valve body.	EA		
*** {Severity H}			
d. Inoperable valve.	EA		
*** {Severity H}			
*** Defective reducing station.**			
Observation:			
a. Station output pressure not maintained at plus or minus 5 psi of tolerance.	EA		
*** {Severity M}			
*** Loose/missing supports/hangers.**			
Observation:			
a. Loose supports/hangers.	EA		
*** {Severity L}			
b. Broken/missing supports/hangers.	EA		
*** {Severity H}			
*** Defective pressure gauges.**			
Observation:			
a. Broken gauge lens.	EA		
*** {Severity L}			
b. Inoperable gauge, no reading.	EA		
*** {Severity F}			
c. Leaking gauge.	EA		
*** {Severity H}			
*** Defective insulation.**			
Observation:			
a. Loose insulation.	LF		
*** {Severity L}			
b. Damaged/missing insulation.	LF		
*** {Severity M}			

32.10 STEAM DISTRIBUTION SYSTEMS

COMPONENTS (Continued)

◆ **32.10.02 PRESSURE REDUCING STATIONS (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
* **Corrosion.**			
Observation:			
a. Surface corrosion (no pitting evident).	LF		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	LF		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	LF		
*** {Severity H}			

32.10 STEAM DISTRIBUTION SYSTEMS

COMPONENTS (Continued)

◆ 32.10.03 STEAM TRAPS

Steam Traps are devices for removing condensate air from the steam heating system. If the trap is inaccessible for the Level I inspection the inspector may choose a Level III inspection method.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Steam loss.**			
Observation:			
a. Trap blows live steam.	EA		2
*** {Severity H}			
b. Broken/damaged steam trap.	EA		2
*** {Severity H}			
*** Continuously discharging condensate.**			
Observation:			
a. Trap is not sized correctly.	EA		
*** {Severity M}			
b. Damaged/defective trap.	EA		2
*** {Severity H}			
*** Cold trap - no discharge.**			
Observation:			
a. No condensate/steam coming to trap.	EA		3
*** {Severity M}			
b. Pipe line/fittings plugged.	EA		3
*** {Severity M}			
c. Strainer plugged.	EA		3
*** {Severity M}			
d. Broken/damaged steam trap.	EA		2
*** {Severity H}			
e. Broken valve in line to trap.	EA		
*** {Severity H}			

32.10 STEAM DISTRIBUTION SYSTEMS

COMPONENTS (Continued)

◆ 32.10.03 STEAM TRAPS (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Hot trap - no discharge.**			
Observation:			
a. No condensate coming to trap.	EA		
*** {Severity M}			
b. Improper installation, trap installed above leaking by-pass valve.	EA		
*** {Severity M}			
c. Broken/damaged steam trap.	EA		2
*** {Severity H}			
d. Noisy high pitch sound.	EA		2
*** {Severity H}			
*** Corrosion.**			
Observation:			
a. Surface corrosion (no pitting evident).	EA		
*** {Severity L}			
b. Surface corrosion evident by pitting or blistering.	EA		
*** {Severity M}			
c. Surface corrosion evident by holes or loss of base metal.	EA		
*** {Severity H}			

32.10 STEAM DISTRIBUTION SYSTEMS

REFERENCES

1. NAVFAC MO-322, Vol. 2, Inspection of Shore Facilities, 1993

2. Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC 1988

3. NAVFAC P-717.0, Department of Defense, Engineered Performance Standards for Real Property Maintenance Activities

4. Hook-up Designs for Steam & Fluid Systems, Sarco Company Inc., 6th Edition

5. NAVFAC MO-209, Maintenance of Steam, Hot Water and Compressed Air Distribution Systems, 1989

32.10 STEAM DISTRIBUTION SYSTEMS

LEVEL II KEY	GUIDE SHEET CONTROL NUMBER
N/A	

LEVEL III KEY	GUIDE SHEET CONTROL NUMBER
1	GS-III 32.10.01-1
2	GS-III 32.10.03-2
3	GS-III 32.10.03-3

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 1

COMPONENT: PIPING, FITTINGS AND VALVES
CONTROL NUMBER: GS-III 32.10.01-1

Application

This guide applies to the detection of a plugged strainer using an infrared thermometer method of testing. This method should be used when the strainer is in an inaccessible location.

Special Safety Requirements

No special safety requirements are needed for the performance of the Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Aim the infrared thermometer at the inlet and outlet of the strainer and record the temperature differential.
2. If the temperature difference is 50 degrees or greater, than it can be assumed that the strainer is not operating properly.
3. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.

Special Tools and Equipment

The following is a list of special tools and equipment beyond those listed in the Standard Tool Section.

1. Infrared thermometer

Recommended Inspection Frequency

Annually

References

1. NAVFAC MO-322, Vol.2, Inspection of Shore Facilities, 1993
2. Hook-up Designs for Steam & Fluid Systems, Sarco Company Inc. 6th Edition
3. The Hartford Steam Boiler Inspection and Insurance Company
4. NAVFAC MO-209, Maintenance of Steam, Hot Water and Compressed Air Distribution Systems, 1989

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2

COMPONENT: STEAM TRAPS
CONTROL NUMBER: GS-III 32.10.03-2

Application

This guide applies to the investigation of the proper operation of a steam trap using a audio amplifier. Considerable experience is required for this method of testing as other noises are telegraphed along the pipe lines. When several traps are close together in the piping system, ultrasonic testers, responding only to frequencies above 35 kilohertz, are useful.

Special Safety Requirements

No special safety requirements are needed for the performance of the Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Observe steam trap operation:
2. Listen for the trap to discharge:
3. Thermostatic traps: When properly sized for the load, will discharge intermittently. Therefore, if the trap is operating properly, a loud hissing sound will be heard during discharge; no sound will be heard when trap is closed. If hissing sound continues after, the trap is leaking.
4. Bucket traps: Will operate intermittently. When the trap is working properly, a hissing noise will be heard during discharge, and when the trap closes, the sound stops.
5. Thermodynamic traps: This type of trap will open and close frequently depending on the trap load and the mechanical condition of the trap. Generally, if the trap cycles fewer than 10 times per minute, it is operating normally.
6. Impulse traps: A bleed hole is drilled through the piston allowing flow from inlet to outlet even when the trap is closed. Therefore, with the trap closed, a hissing sound will be heard. If a loud noise is heard continuously, the trap is either overloaded or stuck in the open position.
7. Float-thermostatic traps: These traps have a tendency to discharge continuously, particularly at low or moderate pressures, and modulate according to the load ahead of the trap. Under these conditions, ultrasonic testers are of no value. However, when float-thermostatic traps are used at high pressures, they tend to discharge intermittently, if the tester indicates a rhythmic intermittent discharge, the trap is working properly.
8. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.
9. Notify appropriate facility personnel for permission to place unit back in service if defect is not critical to continued function.

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 2 (Continued)

COMPONENT: STEAM TRAPS
CONTROL NUMBER: GS-III 32.10.03-2

Special Tools and Equipment

The following is a list of special tools and equipment beyond those listed in the Standard Tool Section.

1. Audio amplifier

Recommended Inspection Frequency

Perform inspection when triggered by Level I inspection or other local factors such as problematic conditions.

References

1. NAVFAC MO-322, Vol.2, Inspection of Shore Facilities, 1993
2. MEANS Facilities Maintenance Standard, Roger W. Liska, PE, AIC, 1988
3. Armstrong Steam Specialty Products, Bulletin No. M101 50M 2/87-0
4. Hook-up Designs for Steam & Fluid Systems, Sarco Company Inc. 6th Edition
5. The Hartford Steam Boiler Inspection and Insurance Company
6. NAVFAC MO-209, Maintenance of Steam, Hot Water and Compressed Air Distribution Systems, 1989

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3

COMPONENT: STEAM TRAPS
CONTROL NUMBER: GS-III 32.10.03-3

Application

This guide applies to the detection of a defective steam trap using an infrared thermometer method of testing. This method should be used when the trap is in an inaccessible location.

Special Safety Requirements

No special safety requirements are needed for the performance of the Level III inspection beyond those required in the Master Safety Plan and System Safety Section.

Inspection Actions

1. Take temperature measurements immediately adjacent, no more than 2 feet, on either side of trap.
2. If the temperature difference is less than 30 degrees F, it can be assumed that the trap is operating properly.
3. Document the problem and contact appropriate facility personnel for further instructions, if defect cannot be determined or is major.

Special Tools And Equipment

The following is a list of special tools and equipment beyond those listed in the Standard Tool Section.

1. Infrared thermometer

Recommended Inspection Frequency

Annually

LEVEL III INSPECTION METHOD GUIDE SHEET

LEVEL III GUIDE SHEET - KEY NO. 3 (Continued)

COMPONENT: STEAM TRAPS
CONTROL NUMBER: GS-III 32.10.03-3

References

1. NAVFAC MO-322, Vol.2, Inspection of Shore Facilities, 1993
2. Means Facilities Maintenance Standard, Roger W. Liska, PE, AIC, 1988
3. Armstrong Steam Specialty Products, Bulletin No. M101 50M 2/87-0
4. Hook-up Designs for Steam & Fluid Systems, Sarco Company Inc. 6th Edition
5. The Hartford Steam Boiler Inspection and Insurance Company
6. NAVFAC MO-209, Maintenance of Steam, Hot Water and Compressed Air Distribution Systems, 1989

32.11 STEAM CONDENSATE RETURN SYSTEMS

DESCRIPTION

Steam Condensate Return Systems is a subsystem of the Central Cooling Plants. The steam condensate return system collects steam condensate and delivers it to the condensate return tank in facilities that have their own heating boiler water to the boiler feedwater system. Condensate is delivered to the condensate return unit if the steam to the facility is supplied by an exterior distribution system.

SPECIAL TOOL AND EQUIPMENT REQUIREMENTS

No special tools are needed for the inspection of Steam Condensate Return Systems, beyond the requirements listed in the Standard Tools Section.

SPECIAL SAFETY REQUIREMENTS

No special safety requirements are needed for the inspection of Steam Condensate Return Systems, beyond the requirements listed in the Master Safety Plan and System Safety Section.

COMPONENT LIST

- 32.11.01 STEAM CONDENSATE RETURN UNIT
- 32.11.02 PIPING, FITTINGS AND VALVES

RELATED SUBSYSTEMS

Due to the related nature of the elements requiring inspection, the following should be reviewed for concurrent inspection activities.

28.07	STEAM DISTRIBUTION SYSTEMS
28.08	STEAM CONDENSATE RETURN SYSTEMS
32.01	CHILLERS - ABSORPTION
32.10	STEAM DISTRIBUTION SYSTEMS

32.11 STEAM CONDENSATE RETURN SYSTEMS

STANDARD INSPECTION PROCEDURE

This subsystem requires both Level I and Level II inspections as part of the basic inspection process. Additional Level II inspections may be indicated or "triggered" by the Level I inspection observation and should be accomplished by the inspector at that time.

For pumps in general use, Level I, II & III inspection methods will apply in accordance with the following gallon-per-minute ranges:

a. Use Level I inspection method if GPM is less than 40.
b. Use Level I, II and/or III inspection methods if GPM is 40 or greater.

For electrical motors in general use, Level I, II & III inspection methods will apply in accordance with the following horsepower ranges:

a. Use Level I inspection method if HP is less than 15.
b. Use Level II inspection method if HP is 15 to 60.
c. Use Level III inspection method if HP is greater than 60.

The Facility Manager will specify the level of inspection required for specialized pump and motor applications.

Associated defects and observations, for each major component, are listed in the inspectors' Data Collection Devices.

COMPONENTS

◆ 32.11.01 STEAM CONDENSATE RETURN UNIT

The steam condensate return unit collects and delivers condensate to the exterior steam condensate return system.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Leakage at tank.**			
Observation:			
a. Water dripping from tank fitting.	EA		
*** {Severity L}			
b. Leakage at tank seams.	EA		
*** {Severity H}			

32.11 STEAM CONDENSATE RETURN SYSTEMS

COMPONENTS (Continued)

◆ 32.11.01 STEAM CONDENSATE RETURN UNIT (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Defective water column.**			
Observation:			
a. Residual buildup inside sight glass, poor visibility.	EA		
*** {Severity L}			
b. Cracked or broken sight glass.	EA		
*** {Severity H}			
*** Physical tank damage.**			
Observation:			
a. Abrasions.	SF		
*** {Severity L}			
b. Impact damage, dents.	SF		
*** {Severity M}			
*** Defective insulation.**			
Observation:			
a. Loose insulation.	SF		
*** {Severity L}			
b. Missing or damaged insulation.	SF		
*** {Severity H}			
*** Damaged pump.**			
Observation:			
a. Cracked pump housing.	EA		
*** {Severity M}			
b. Broken pump base.	EA		
*** {Severity H}			
*** Leakage at pump.**			
Observation:			
a. Leaking or damaged pump seals.	EA		
*** {Severity M}			
b. Leaking pump flange.	EA		
*** {Severity M}			

32.11 STEAM CONDENSATE RETURN SYSTEMS

COMPONENTS (Continued)

◆ 32.11.01 STEAM CONDENSATE RETURN UNIT (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Excessive noise and vibration at pump.**			
Observation:			
a. Rattling noise.	EA		
*** {Severity M}			
b. Grinding noise, indicating metal to metal contact.	EA		
*** {Severity H}			
*** Damaged motor.**			
Observation:			
a. Cracked/damaged housing or end bells.	EA		
*** {Severity M}			
b. Broken motor base.	EA		
*** {Severity H}			
*** Excessive noise and vibration at motor.**			
Observation:			
a. Rattling noise.	EA		
*** {Severity M}			
b. Grinding noise, indicating metal to metal contact.	EA		
*** {Severity H}			
*** Physically damaged controls.**			
Observation:			
a. Missing or damaged level switches.	EA		
*** {Severity H}			
*** Defective electrical connectors.**			
Observation:			
a. Loose conduit or connectors.	EA		
*** {Severity F}			
b. Exposed wires or missing cover plates.	EA		
*** {Severity F}			

32.11 STEAM CONDENSATE RETURN SYSTEMS

COMPONENTS (Continued)

◆ 32.11.01 STEAM CONDENSATE RETURN UNIT (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corrosion at tank.**			
Observation:			
a. Surface corrosion no pitting evident.	SF		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	SF		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	SF		
*** {Severity H}			

32.11 STEAM CONDENSATE RETURN SYSTEMS

COMPONENTS (Continued)

◆ 32.11.02 PIPING, FITTINGS AND VALVES

Piping, fittings and valves provide the collection and discharge network for the steam condensate return system.

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Defective fittings.**			
Observation:			
a. Bent or cracked fitting, not leaking.	EA		
*** {Severity L}			
b. Water leaking.	EA		
*** {Severity H}			
*** Defective pipe.**			
Observation:			
a. Bent or cracked pipe, not leaking.	LF		
*** {Severity L}			
b. Water leaking.	LF		
*** {Severity H}			
*** Defective valves.**			
Observation:			
a. Broken or missing valve handle.	EA		
*** {Severity L}			
b. Bent stem.	EA		
*** {Severity M}			
c. Leaking valve packing glands/gaskets.	EA		
*** {Severity M}			
d. Cracked valve body.	EA		
*** {Severity H}			
*** Defective supports or hangers.**			
Observation:			
a. Loose supports or hangers.	EA		
*** {Severity L}			
b. Broken or missing supports or hangers.	EA		
*** {Severity H}			
*** Defective insulation.**			
Observation:			
a. Loose insulation.	LF		
*** {Severity L}			
b. Missing or damaged insulation.	LF		
*** {Severity H}			

32.11 STEAM CONDENSATE RETURN SYSTEMS

COMPONENTS (Continued)

◆ 32.11.02 PIPING, FITTINGS AND VALVES (Continued)

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Corroded piping and fittings.**			
Observation:			
a. Surface corrosion (no pitting evident).	LF		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	LF		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	LF		
*** {Severity H}			
*** Corroded valves.**			
Observation:			
a. Surface corrosion (no pitting evident).	EA		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	EA		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	EA		
*** {Severity H}			
*** Corroded hangers or supports.**			
Observation:			
a. Surface corrosion (no pitting evident).	EA		
*** {Severity L}			
b. Corrosion evidenced by pitting or blistering.	EA		
*** {Severity M}			
c. Corrosion evidenced by holes or loss of base metal.	EA		
*** {Severity H}			

32.11 STEAM CONDENSATE RETURN SYSTEMS

COMPONENTS (Continued)

◆ **32.11.02 PIPING, FITTINGS AND VALVES (Continued)**

Defect:	UOM	LEVEL II KEY	LEVEL III KEY
*** Defective pipe labeling.**			
Observation:			
a. Damaged or missing labels.	EA		
*** {Severity L}			

32.11 STEAM CONDENSATE RETURN SYSTEMS

REFERENCES

1. NAVFAC MO-322, Vol. 2, Inspection of Shore Facilities, 1993

2. Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC, 1988

3. NAVFAC P-717.0, Department of Defense, Engineered Performance Standards for Real Property Maintenance Activities

4. Hook-up Designs for Steam & Fluid Systems, Sarco Company Inc. 6th Edition

5. NAVFAC MO-209, Maintenance of Steam, Hot Water and Compressed Air Distribution Systems, 1989

32.11 STEAM CONDENSATE RETURN SYSTEMS

LEVEL II KEYS GUIDE SHEET CONTROL NUMBER

N/A

LEVEL III KEYS GUIDE SHEET CONTROL NUMBER

N/A

APPENDIX A

ABBREVIATIONS

AIC	American Institute of Chemists
CAIS	Condition Assessment Information System
CAS	Condition Assessment Survey
CERL	Construction Engineering Research Laboratory
DCD	Data Collection Device
DIA	Diameter
EA	Each
FT	Foot
GPM	Gallons Per Minute
GS	Guide Sheet
HP	Horsepower
HR.	Hour
IE	That is
IU	Inspection Unit
LF	Linear Foot
N/A	Not Applicable
NAVFAC-MO	Naval Facilities Maintenance and Operations
NDT	Non-Destructive
OS&Y	Outside Stem and Yoke
PE	Professional Engineer
PM	Preventive Maintenance
PVC	Polyvinyl Chloride

APPENDIX A

RPIL	Real Property Inventory List
SF	Square Foot
TM	Technical Manual
UOM	Unit Of Measurement
YRS	Years
WBS	Work Breakdown Structure
°	Degrees of Temperature
°C	Degrees Centigrade
°F	Degrees Fahrenheit
=	Equals
'	Feet
>	Greater Than
≥	Greater Than or Equal To
"	Inches
<	Less Than
≤	Less Than or Equal To
/	Per or Over
%	Percent
+	Plus or Positive or Add
±	Plus or Minus
−	Subtract or Minus or Negative
·	Times or By
x	Times or By

APPENDIX B

GLOSSARY

Abrasions	A scraping or rubbing off, as of skin. A wearing away by rubbing or scraping, as of rock by wind and water.
Absorbent	A material able to take up another material (in the fashion of a sponge), into the physical structure of a solid without a chemical reaction.
Actuator	A controlled motor that can effect a change in the controlled variable (temperature, pressure) by operating a control element such as a valve or damper.
Agitator	Device used to cause motion in a confined fluid.
Air Foil	A part with a flat or curved surface, as a wing or a rudder, designed to be placed at a point where the flow changes direction, used to promote a more uniform flow and to reduce pressure drop.
Algae	A group of plants, variously one-celled, colonial, or filamentous, containing chlorophyll and other pigments and having no true root, stem, or leaf; algae are found in water or damp places and include seaweed and pond scum.
Alignment	An aligning or arrangement in a straight line; a ground plan , as of a field work , railroad etc.
Ammeter	An instrument for measuring the strength of an electric current (rate of flow) in terms of amperes.
Arcing	The band of sparks or incandescent light formed when an electric discharge is conducted from one electrode or conducting surface to another, characterized by relatively high current and low potential difference between electrodes.
Axial Fan Blade	Part of a fan that produces pressure from the velocity of air passing through the impeller, with no pressure being produced by centrifugal force.
Base Metal	The metal to be welded, soldered, or plated.
Bearings	The support for a shaft, axle, or trunnion used to mediate friction; usually in conjunction with a lubricant.

APPENDIX B

Blistering	To cause blisters (an enclosed pocket of air mixed with water or solvent vapor, trapped between impermeable layers of material and the substrate.
Blower	A fan usually one for heavy-duty application, e.g. a fan that forces fresh air through a duct system.
Brushes	A conductive metal or carbon block used to make sliding electrical contact with a moving part.
Burners	The part of a boiler or furnace in which combustion takes place.
Calipers	An instrument with two legs or jaws that can be adjusted for measuring linear dimensions, thickness, or diameter.
Catch Basin	A basin at the point where a street gutter empties into a sewer, built to stop matter that would not easily pass through the sewer. A well or reservoir into which surface water may drain off.
Centrifugal	Moving or tending to move away from a center (conveying away from a center).
Ceramic	A product made by the firing or baking of a nonmetallic mineral, such as tile, cement, plaster refractories and brick.
Chiller: Absorption	An absorption chiller uses water as the primary refrigerant and employs an absorbent as a secondary fluid. Unlike the centrifugal, reciprocating or screw units, it uses a physio-chemical process and employs little mechanical energy.
Chiller: Centrifugal	Compresses gaseous refrigerant using centrifugal force and produces cooling via water, through a shell and tube evaporator.
Chiller: Screw	Compresses gaseous refrigerant using helical rotors and produces cooling via water, through a shell and tube evaporator.
Coil	A term applied to a heat exchanger that uses connected pipes or tubing in rows, layers, or windings, as in steam heating, water heating, and refrigeration condensers and evaporators.
Cold Deck	The area of a cooling tower, at the base of the system from which the cooled fluid is collected and sent back into the system toward the heat source.

APPENDIX B

Commutator	That part of a direct-current motor or generator which serves the dual function, in combination with brushes, of providing an electrical connection between the rotating armature winding and the stationary terminals, and of permitting reversal of the current in the armature windings.
Compressor	A machine for compressing air or other gases.
Concentrator	An apparatus used to concentrate materials.
Concrete Cracks	Hairline cracks are defined as shallow cracks that are the width of a human hair, normally occur in a random pattern and result in no loss of surface. Medium and larger cracks can be larger than a hairline size and normally follow a pattern and result in surface loss.
Condenser	The heat exchanger in a refrigeration system that removes heat from the hot high-pressure refrigerant gas and transforms it into a liquid.
Condenser: Air Cooled	A heat exchanger which transfers heat to surrounding air.
Condenser: Tube-Within-A-Tube	A water-cooled condensing unit in which a small tube is placed inside a larger unit. Refrigerant passes through one tube; water through the other.
Condenser: Water Cooled	Heat exchanger which is designed to transfer heat from hot gaseous refrigerant to water.
Conditioned Air	Air that has been treated so as to control simultaneously its temperature, humidity, cleanliness and distribution to meet the requirements of the conditioned space.
Conduit	A tube or pipe used to protect electric wiring. A tube or pipe used for conveying fluid.
Connectors	In an electrical circuit, a device for joining two or more conductors, by a low-resistance path, without the use of a permanent splice.
Contamination	To be made impure, infected, corrupt, radioactive, etc. by contact with or addition of something; pollution; tainted.
Controls	Automatic or manual device used to stop, start, and/or regulate flow of gas, liquid, and/or electricity.

APPENDIX B

Cooling Tower	A tall structure in which atmospheric air circulates and cools warm water, generally by direct contact (evaporation).
Corrosion	The deterioration of metal or of concrete by chemical or electrochemical reaction resulting from exposure to weathering, moisture, or chemicals, or other agents in the environment in which it is placed.
Couplings	A metal collar with internal threads used to connect two sections of threaded pipe. The mechanical fastening that connects shafts together for power transmission.
Crankcase	The metal housing that encloses the crankshaft of an internal-combustion engine.
Current Draw	The demand of a piece of equipment which determines the flow or rate of flow of electric charge in a conductor or medium between two points having a difference in potential, generally expressed in terms of amperes.
Cycle (N)(V)	A period of time within which a round of regularly recurring events or phenomena is completed.
Cylinder Heads	The cap which serves to close the end of the piston chamber of a reciprocating engine, pump, or compressor.
Damper	A device used to vary the volume of air passing through an air outlet, inlet, or duct; it does not significantly affect the shape of the delivery pattern. A pivoted cast-iron plate at the fireplace throat, i.e. between fireplace and smoke chamber, to regulate draft.
Debris	Rough, broken, bits and pieces of stone, wood, glass, etc. as after destruction; rubble. Bits and pieces of rubbish; litter. A heap of rocks.
Deformation	Any change of form, shape, or dimensions produced in a body by a stress or force, without a breach of the continuity of its parts.
Degradation	To lower or corrupt in quality, value, etc.. The lowering of land surfaces by erosion. To convert an organic compound into a simpler compound by removal of one or more parts of a molecule.
Dielectric	A nonconductor of electricity; an insulator or insulating material.

APPENDIX B

Dielectric (unions)	A pipe fitting that is used to connect the ends of two pipes, neither of which can be turned; it consists of three pieces, the two end pieces (having inner threads), which are tightened around the pipe ends to be joined, and a center piece, which draws the two end pieces together as it is rotated, effecting a seal. It is made of material which contains an electrical insulator; which is used to prevent a electrolytic reaction and thus prevent corrosion.
Direct Expansion	Refrigeration systems that employ expansion valves or capillary tubes to meter fluid refrigerant into the evaporator.
Discharge	To throw off; send forth; emit; to relieve of excess pressure. To remove stored energy from a battery or capacitor. To emit waste matter; to be released.
Dissipation	A scattering or being scattered; dispersion. A wasting or squandering as of heat in a cooling tower.
Distortion	A twisting out of shape; changing the usual or normal shape, form, or appearance.
Divert	To turn aside from a course or direction.
Drive Assembly	The means by which a machine is given power or motion (as in steam drive or diesel-electric drive), or by which power is transferred from one part of an engine to another (as in gear drive or belt drive).
Drive Shaft	A shaft which transmits power from a motor or engine to the rest of a machine.
Dye Penetrant	A liquid with low surface tension, containing a dye or florescent chemical; which when flowed over a metal surface, is used to determine the existence and extent of cracks and other discontinuities.
Economizer	A forced-flow once-through, convection-heat-transfer tube bank in which feedwater is raised in temperature on its way to the evaporating section of a steam boiler, thus lowering flue gas temperature improving boiler efficiency, and saving fuel.

APPENDIX B

Eddy Current Test	A non-destructive test that involves the observation of the interaction between electromagnetic fields and metals. A coil containing a high-frequency electric current is used to generate a magnetic field in the specimen; this generates eddy currents in the specimen. The impedance caused by a change in the uniformity of the specimen's structure will signal the presence of a flaw in the metal. Useful for detecting cracks, pitting, corrosion or other flaws that inhibit the flow of electric current.
Electronic Leak Detector	An instrument used to detect small holes or cracks in the walls of a vessel.
End Bells	A hollow metal cylinder closed at one end and flared at the other. A conical device that seals the top of a blast furnace.
Erosion	The deterioration brought about by the abrasive action of fluids or solids in motion.
Evaporator	The heat exchanger in a refrigeration system that removes heat from the media being cooled (air or chilled water). It takes low-pressure, low-temperature refrigerant liquid and transforms it into a gas. The two types of evaporators in which refrigerant liquid is vaporized are direct expansion coils and shell and tube water chillers. Any of many devices in which liquid is changed to vapor state by the addition of heat, for example, distiller, still, dryer, water purifier, or refrigeration system element where evaporation proceeds at low pressure and consequent low temperature.
Expansion Tanks	A vessel to control pressure in a hydraulic system by storing excess volume resulting from increased operating temperatures.
Fans	A radial or axial flow device used for moving or producing artificial currents of air.
Fan: Axial	A fan that produces pressure from the velocity of air passing through the impeller, with no pressure being produced by centrifugal force.
Fan: Centrifugal	A fan within a scroll-type housing, which receives air perpendicular to the axis of rotation and discharges it radially; by pushing it away from the center of rotation; may be either belt driven or connected directly to a motor. A fan rotor or wheel within a scroll type of housing including driving mechanism supports for either belt drive or direct connection.

APPENDIX B

Fan: Propeller	A propeller or disc-type wheel within a mounting ring or plate including driving mechanism supports for either belt drive or direct connection.
Fatigue	The tendency of a metal or other material to crack and fail under repeated applications of stress.
Fill	Material placed in a cooling tower for the purpose of facilitating direct contact between circulating water and air.
Fin Tube	A heat exchange device consisting of a metal tube through which water or steam may be circulated. Metal plates or fins are attached to the outside of the tube to increase the heat transfer surface. Finned tube or fin tube may consist of one, two, or three tiers and are designed for installation bare or with open type grilles, covers, or enclosures having top, front, or inclined outlets.
Fitting	A pipe part, usually standardized, such as a bend, coupling, cross, elbow, reducer, tee, union, etc.; used for joining two or more sections of pipe together. The term usually is used in the plural. An accessory such as a bushing, coupling, locknut, or other part of an electric wiring system which is intended to perform a mechanical rather than an electrical function.
Float Valve	A valve whose on-off action is controlled directly by the rise or fall of a float concurrent with the fall or rise of liquid level in a liquid-containing vessel.
Galvanic Action	An electrochemical action which takes place when dissimilar metals are in contact in the presence of an electrolyte, resulting in corrosion.
Gaskets	A continuous strip of resilient material attached to a panel or frame to provide a tight seal between the frame and the panel. Any ring of resilient material used as a joint to prevent leakage.
Generator	A machine for changing mechanical energy into electrical energy.
Glycol	A colorless dihydroxy alcohol used as an antifreeze and in hydraulic fluids.
Headers	A piping arrangement for interconnecting two or more supply or return tappings of a system. Also a section of pipe, usually short in length, to which a number of branch circuits are attached.

APPENDIX B

Heat Exchanger	Any device, such as an automobile radiator, that transfers heat from one fluid to another or to the environment.
Hermetic	Completely sealed by fusion, soldering, etc. so as to keep air or gas from getting in or out; airtight.
Housing	In a pump, motor, or fan the casing or enclosure which contains the parts of the piece and acts to protect the enclosed machinery.
Impellers	The rotating member of a fan, turbine, blower, axial or centrifugal pump, or mixing apparatus. Also known as a rotor.
Infrared Temperature Tester	An instrument that focuses and detects the infrared radiation (heat energy) emitted by an object in order to determine its temperature.
In-Line	Over the center of a borehole and parallel with its long axis. Often said of a pump that is connected directly to the pipe system as a booster.
Insulation	A material providing high resistance to heat flow; usually made of mineral wool, cork, asbestos, foam glass, foamed plastic, diatomaceous earth, etc. fabricated in the form of batts, blankets, blocks, boards, granular fill and loose fill.
Isolate	To set apart from others; place alone. To separate (an element or compound) in pure form from substances with which it is combined or mixed.
Isolators	A passive attenuator in which the loss in one direction is much greater than in the opposite direction; a ferrite isolator for waveguides is an example. Any device that absorbs vibration or noise, or prevents its transmission.
Lap	To place partly on something else (to lap a seam).
Latent Heat	The amount of heat absorbed or evolved by a unit of mass of a substance during a change of state (such as fusion, sublimation, or vaporization).
Level	A horizontal line or plane; especially such a plane taken as a basis for the measure of elevation.

APPENDIX B

Life Cycle	Under normal conditions, the expected life span based on proper installation and preventive maintenance.
Lithium Bromide	A chemical compound (salt) with the ability to absorb water and cool it by evaporation.
Lock-out	To make a valve or circuit inoperative by shutting out and putting padlocks or other restrictive devices on the unit and identifying the lock-out with a card or sign.
Lubricate	To reduce friction by providing a smooth film as a covering over parts that move against each other. To make slippery or smooth, to apply a lubricant.
Members	One of a number of units which when assembled together becomes an integral part of the entire building, unit or structure.
Modulate	To regulate, adjust, or adapt to the proper degree.
Nozzles	A tube-like device, usually streamlined, for accelerating and directing a fluid, whose pressure decreases as it leaves the device.
Packing Glands	Packing is the stuffing or elastic material around a shaft or valve stem or around a joint to prevent leakage. A stuffing box surrounds a shaft to prevent leakage by the use of packing; commonly used on water pumps; the packing gland is a movable part that compresses the packing in the stuffing box.
Pedestal	A support for a column, statue, or piece of machinery. An upright compression member the height of which does not exceed three times its least lateral dimension.
Pilot Lamps	A light which is associated with and indicative of the operation of a circuit, control, or device.
Piston	A disk or short cylinder closely fitted in a hollow cylinder and moved back and forth by the pressure of a fluid so as to transmit reciprocating motion to the piston rod attached to it, or moved by the rod to exert pressure on the fluid.
Pitting	The development of small cavities in a surface, owing to phenomena such as corrosion, cavitation, or (as in concrete) localized disintegration. The development of surface defects on a metal surface, e.g. small depressions, usually caused by electrochemical corrosion.

APPENDIX B

Plumb	Exactly vertical.
Pop-outs	A conical fragment that has broken out of the surface of the concrete leaving small holes. Generally a shattered aggregate particle will be found at the bottom of the hole, with a part of the fragment still adhering to the small end of the pop-out cone. Pop-outs are caused by reactive aggregates and high alkali cement. They are also caused by aggregates such as shale, which expand with moisture.
Propeller	Consisting typically of two or more blades twisted to describe a helical path as they rotate with the hub in which they are mounted and serving to propel a fluid or gas.
Pumps	A machine that draws a fluid into itself through an entrance port and forces the fluid out through an exhaust port. A motor driven device used to mechanically circulate fluid in a system; also called a circulator.
Purge Units	Used to evacuate air or gas from a duct line, pipeline, container, space or furnace, e.g. to blow out gas from a refrigerant containing vessel.
Reciprocating	Moving alternately back and forth; interchange position.
Refrigerant	A substance that by undergoing a change in phase (liquid to gas, gas to liquid) releases or absorbs a large latent heat in relation to its volume, and thus effects a considerable cooling effect. Examples are ammonia, sulfur dioxide, lithium bromide,and the fluorocarbons, such as Freon.
Reservoir	A place where anything is collected and stored, generally in large quantity; especially a lake or pond in which water is stored for use. A receptacle or part in an apparatus for holding a fluid, as oil, ink, etc..
Rot	Decomposition in wood by fungi and other microorganisms; reduces the strength, density, and hardness.
Rotor	The rotating member of an electrical machine or device such as the rotating armature of a motor or generator or the rotating plates of a variable capacitor.
Run-out Play	This term generally applies to the horizontal of branch circuits or the measurement of play in a bearing or shaft.

APPENDIX B

Scale	The product resulting from the corrosion of metals. A heavy oxide coating resulting from exposure to high temperatures in an oxidizing atmosphere. A weighing device.
Scaling	The gradual and continuing loss of surface mortar and aggregate over an area; due to the failure of the cement paste caused by chemical attack or freeze/thaw cycles.
Seals	A tight closure as against the passing of air and water, something that closes or fastens tightly or securely.
Seams	The joint between two sheets of material.
Sensors	A material or device which goes through a physical change or an electronic characteristic change as the conditions change, thus detecting a change in ambient conditions; used to initiate an action such as an alarm or open a valve.
Set Screws	A screw used to fix a collar, knob or other detachable part to a shaft or part of a machine.
Shaft	A bar or cylinder supporting or transmitting motion to a mechanical part.
Shell and Tube Heat Exchanger	A device using an outer cylinder to contain the cooling fluid and tubes on the interior of the cylinder to contain the heated fluid that transfers heat from one fluid to another.
Shot Tanks	A vessel used to deliver a measured dose of a chemical into the flow stream of a liquid.
Sight Glasses	A glass tube sealed within a fluid system, providing a means to examine (visually) the fluid within the system.
Slime	Any soft, moist, slippery, sometimes sticky matter, as thin mud or mucous.
Spalling	A roughly circular or oval depression in the concrete. Spalls result from the separation and removal of a portion of the surface concrete, revealing a fracture roughly parallel to the surface. Spalls can be caused by corroding reinforcement steel and friction from thermal movement; reinforcing steel is often exposed.
Spectrochemical	The branch of chemistry dealing with the analysis of the spectra of substances.

APPENDIX B

Stator	A fixed part forming the pivot or housing for a revolving part (rotor), as in a motor, dynamo.
Suction	The production of a vacuum or partial vacuum in a cavity or over a surface so that the external atmospheric pressure forces the surrounding fluid into the cavity or causes something to adhere to the surface.
Sumps	A pit, tank, basin, or receptacle which receives sewage or liquid waste, located below the normal grade of the gravity system, and which must be emptied by mechanical means. A reservoir sometimes forming part of a roof drain. A depression in a roof deck where the roof drain is located.
Tension	Stress on a material produced by the pull of forces tending to cause extension. A force or combination of forces exerting such a pull against the resistance of the material. The expansive force or pressure, of a gas or vapor.
Terminal	The point where the controlled fluid enters or leaves the distribution system. These are supply terminals on water terminals, supply outlets on air terminals. An electrically conductive element, attached to the end of a conductor or piece of equipment for connection to an external conductor. The ornamental finish, decorative element, or termination of an object, item of construction, or structural part.
Tubes	Fluid carrying pipe which has a thin wall.
Valves	A device which regulates or controls the flow of a liquid or gas.
Vibrations	Rapid, periodic, to-and-fro motion or oscillation of an elastic body or the particles of a fluid when displaced from the rest position or position of equilibrium, as in transmitting sound.
Volume	The amount of space occupied in three dimensions; cubic contents; a large quantity, bulk. Any of a set making up a matched set or a complete work.
Weld	To unite metals by heating them to suitable temperatures, with or without the application of pressure, and with or without the use of filler metal.

APPENDIX B

Wet Bulb Temperature	Air temperature indicated by a thermometer whose bulb is covered with a wet wick. As the moisture from the wick evaporates, the air will be slightly cooler than the dry bulb reading in the same area.
Wet Deck	The area at the top of a cooling tower from which the fluid to be cooled enters the tower.

APPENDIX C

LIFE CYCLES

32 CENTRAL COOLING PLANTS

32.01 CHILLERS - ABSORPTION

Chillers - Absorption	23 YRS

Source:
Means Estimating Handbook, R.S.Means Company, Inc., 1990

32.02 CHILLERS - CENTRIFUGAL

Chillers - Centrifugal	23 YRS

Source:
Means Estimating Handbook, R.S.Means Company, Inc., 1990

32.03 CHILLERS - RECIPROCATING

Chillers - Reciprocating	20 YRS

Source:
Means Estimating Handbook, R.S.Means Company, Inc., 1990

32.04 CHILLERS - SCREW

Chillers - Screw	20 YRS

Source:
Means Estimating Handbook, R.S.Means Company, Inc., 1990

32.05 CHILLED WATER DISTRIBUTION SYSTEMS

Pumps	15 YRS
Motors	15 YRS
Controls	15 YRS
Expansion Tanks	20 YRS
Piping and Fittings	30 YRS
Valves	15 YRS

Source:
Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC, 1988

APPENDIX C

32.06 CONDENSER WATER DISTRIBUTION SYSTEMS

Pumps	15 YRS
Motors	15 YRS
Controls	15 YRS
Piping And Fittings	30 YRS
Valves	15 YRS

Source:
Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC,1988

32.07 COOLING TOWERS/EVAPORATIVE CONDENSERS

Enclosures, Fill, Frame - Wood (redwood treated)	20 YRS
Enclosures, Fill, Frame - Metal (aluminum, Galvanized steel)	20 YRS
Enclosures, Fill, Frame - Fiberglass	15 YRS
Enclosures, Fill, Frame - Ceramic	34 YRS
Enclosures, Fill, Frame - PVC	15 YRS
Fans/Blowers/Drive Assemblies	18 YRS
Pumps	20 YRS
Motors	18 YRS
Condensing Coil	20 YRS
Dampers	20 YRS
Metal Ladders, Stairways, Railing	20 YRS

Source:
Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC, 1988

32.08 AIR COOLED CONDENSER - FLUID COOLER SYSTEMS

Air Cooled Condensers	15 YRS
Fluid Coolers	15 YRS

Source:
Means Estimating Handbook, R.S.Means Company, Inc., 1990

32.09 CHEMICAL WATER TREATMENT SYSTEMS

Chemical Water Treatment System	15 YRS

Source:
Means Estimating Handbook, R.S.Means Company, Inc., 1990

APPENDIX C

32.10 STEAM DISTRIBUTION SYSTEMS

Piping And Fittings	30 YRS
Valves	15 YRS
Pressure Reducing Stations	20 YRS
Steam Traps	5 YRS
Strainers	20 YRS

Source:
Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC, 1988

32.11 STEAM CONDENSATE RETURN SYSTEMS

Pumps	15 YRS
Motors	15 YRS
Controls	15 YRS
Condensate Return Tanks	20 YRS
Piping and Fittings	30 YRS
Valves	15 YRS

Source:
Means Facilities Maintenance Standards, Roger W. Liska, PE, AIC, 1988